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ELECTRICAL REVIEW

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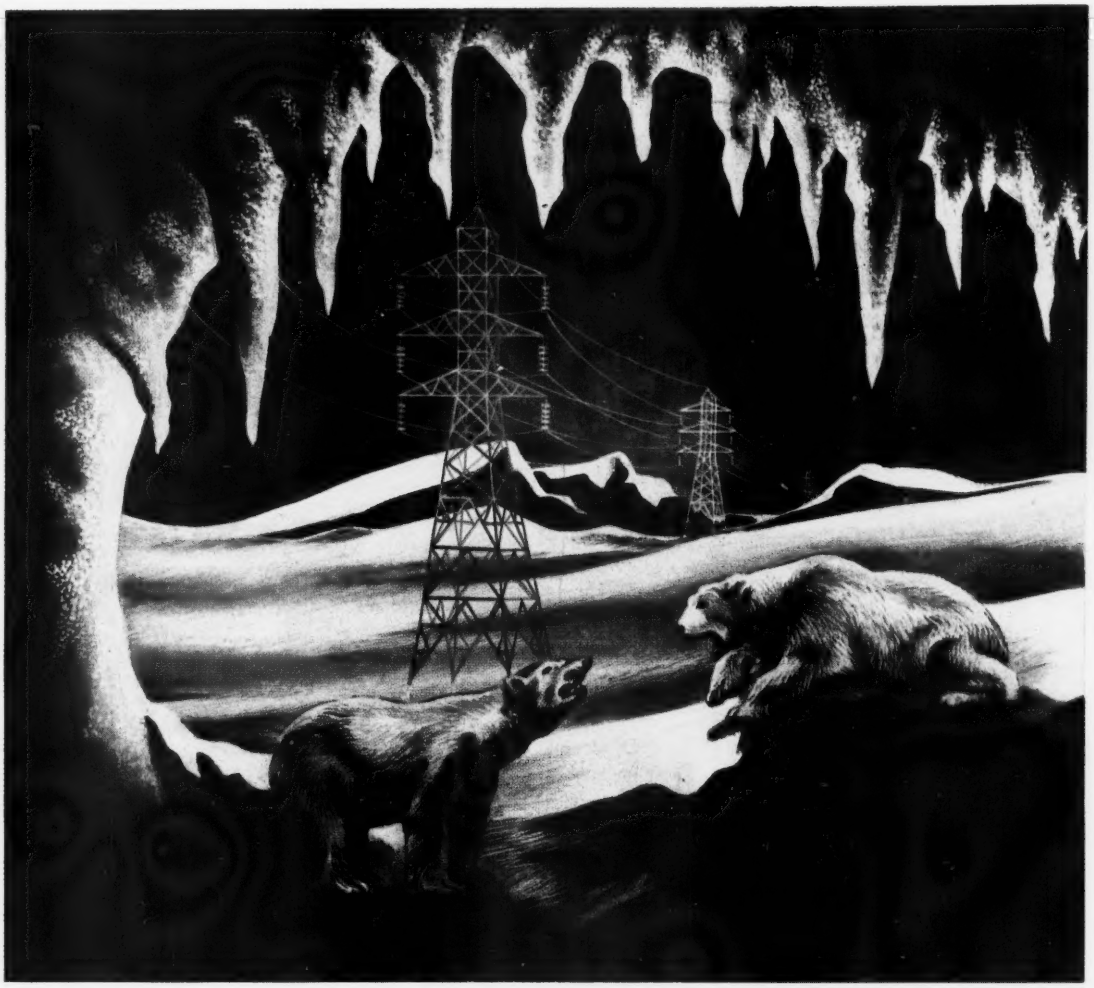

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23 DECEMBER 1955

In This Issue

1199 AUTOMATIC CONTROL AND PRODUCTIVITY
1201 PORTABLE ELECTRIC TOOLS
1205 RAILWAY ELECTRIFICATION IN SPAIN
1207 VIEWS ON THE NEWS
1208 PERSONAL AND SOCIAL
1211 PARLIAMENTARY REPORT
1213 BRITAIN'S ENERGY PROSPECTS
1214 INDUSTRIAL NEWS
1217 MODERN STEELMAKING
1221 ENGINEERING IN EUROPE
1223 LAPLACE TRANSFORMATION
1225 PRESSURIZED WATER REACTOR
1227 275 kV SWITCHING STATION
1229 MEXICAN RURAL ELECTRIFICATION
1231 MAXIMUM HUMIDITY
1233 NEW ELECTRICAL EQUIPMENT
1234 GENERATION AND DEVELOPMENT
1237 FINANCIAL SECTION
1239 CANADIAN ELECTRICAL TRADE
1240 NEW PATENTS
1242 CONTRACT INFORMATION

81 CLASSIFIED ADVERTISEMENTS
94 INDEX TO ADVERTISERS

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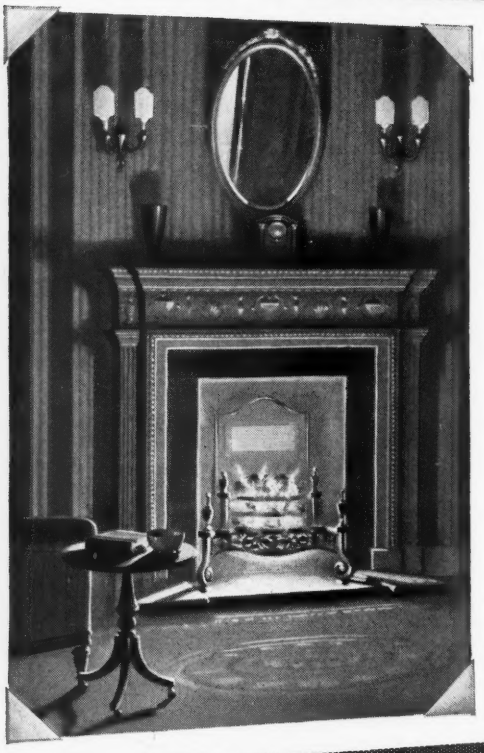

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ELECTRICAL REVIEW

23 December 1955 Vol. 157 No. 26 Established 1872

Automatic Control and Productivity

IN his inaugural address as chairman of the Measurement and Control Section of the Institution of Electrical Engineers (*Electrical Review*, 21st October), Mr. W. Bamford said that automatic control was an evolutionary extension of the industrial revolution which was itself based upon two centuries of scientific discoveries and their application to industry, accompanied by increased demands for manufactured products.

This statement is a badly needed corrective of the tendency to regard a new major industrial development (nuclear energy) and a phase (automation) in a development of very long standing (automatic control) as likely to bring about a second industrial revolution.

In these early days in the development of nuclear energy it is impossible to say that the use of this form of energy will not be revolutionary in character, but all the while nuclear energy remains basically another means of generating electricity the continued development of automatic (electric) control will contribute far more to increasing productivity by enabling man to transmit instructions to machines at the high rate at which the machines can accept them, and not merely at the rate at which man can operate the machines.

In his inaugural lecture at the Imperial College of Science and Technology (*Electrical Review*, 16th December) Professor Tustin said that the suggestion that progress indicative of a spectacular rise in our standard of living was more or less guaranteed by the promise of nuclear power, together with the advent of the automatic factory, could not be accepted. Sir George Barnett, H.M. Chief Inspector of Factories, in his annual report for 1954 (*Electrical Review*, 16th December), says that we are only at the beginning of this new development (automation) which is being hailed by visionaries as the second industrial revolution. While he had no doubt that automation had a considerable future for mass production he did not visualize any drastic overnight changes.

It is becoming increasingly evident that if we are to survive as a competitive nation we must continue to raise the efficiency of production. And there is only one way to do this, namely, by still further electrification which means adopting a higher degree of electrical control. What single industry is there whose output has not been raised very considerably by the adoption of improved electrical methods in recent years? This has meant the increasing employment of all forms of electrical control—electromagnetic, electrothermal and electronic—all contributing to the realization of "automation." This progress has been founded on an ever-growing appreciation of the great advantages to be derived from electric control, and progress can be accelerated by bringing these advantages to the attention of a wider circle of industrialists.

FUEL AND PRODUCTIVITY

In forecasting fuel needs of the future, it is useful to bear in mind that the rapid increase in inland coal consumption since 1945 is but a reversion to conditions that obtained 100 years ago at the height of Victorian prosperity. It contrasts with the virtually stationary state of mining output during the inter-war years, during which industrial production increased by 2 per cent each year, compared with the 5 per cent each year since 1946. The significance of the relationship between the rates of growth of fuel consumption and industrial activity was emphasized by Dr. G. H. Daniel in his Viscount Nuffield Paper, summarized on another page. The increase in fuel consumption of 15 per cent that accompanied a 20 per cent increase in real income from 1948 to 1954 can hardly be expected to continue in the same ratio owing to possible changes in the industrial pattern, power economy due to automatic control and higher efficiency in electricity generation, but in scaling down the 0·75/1 ratio to 0·7/1, Dr. Daniel probably goes as far as is safe by present indications.

OLD AND NEW TECHNOLOGIES

At the inaugural meeting of the British Nuclear Energy Conference in London, reported in the *Electrical Review* of 9th December, Sir Christopher Hinton, chairman of the Conference, said: —

> "Nuclear energy should not be regarded as a completely new technology, but rather as an extension of existing technologies. Indeed, we ought to attribute our present satisfactory position in the field of nuclear energy not to our ability to evolve technologies which are completely new or revolutionary, but rather to the ability which has been shown in adapting and developing existing techniques to problems which are completely new."

We really thought that it all began with the splitting of the atom by Rutherford little more than twenty years ago; and in the development of a new science 20-odd years is quite a short time. The design and construction of nuclear energy reactors is a very much more recent development, so we are forced to believe that Sir Christopher would have us think mainly of the heat transfer problems involved in getting energy from the reactor to the steam producing plant of the nuclear power station.

COURSES FOR TECHNICIANS

In our last issue we published a report of the proceedings of a conference held at the Institution of Electrical Engineers on "Courses for Electrical Technicians" when the scheme of courses drawn up by the City and Guilds of London Institute was discussed. We were glad to read in the report that Mr. M. W. Humphrey Davies, chairman of the City and Guilds Institute committee responsible for the syllabus, said that the new courses placed less emphasis on the mathematical and more on the practical aspects of electrical engineering, and that they should appeal to the student who found the national certificate course too difficult. It was also pleasing to find that Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd., considered that the national certificate courses would remain as a route—though an arduous one—to professional status, and that the higher national certificate in its own right would continue as an appropriate qualification for many high-grade electrical "technicians." These points clear the air somewhat, but not entirely, on doubts and confusion relating to the terms technician, technologist and professional engineer, and make it more evident than does the latest "Report on Courses for Electrical Technicians" that the courses are not designed for the last two categories. This, we think, means that the courses should not be confused with the degree courses of the universities which provide a very much wider scope for, say, the professional engineer who, to use, in effect, a definition of the I.E.E., is fitted by reason of his academic training to deal with the fundamentals of science. All the same we are still not quite so clear on the definitions of the other two types of engineers.

APPLIANCE SALES

The inclusion of certain electrical appliances previously exempt in the scope of purchase tax and the increase in the rates already operating on other appliances are bound to have an adverse effect upon sales. But as most of them are by no means luxuries and must be bought anyhow that effect may not be so marked as the Chancellor intended it to be. It would seem that the more onerous hire-purchase terms are likely to have more influence. Already there has been a slowing-up of sales of domestic equipment from this cause. A *Financial Times* survey suggests that while sales of self-contained water heaters, cookers, washing machines and vacuum cleaners have fallen, refrigerators and immersion heaters have been purchased steadily and sales of fires have actually risen. It is believed that business in gas appliances has been more seriously hit. There again, however, sales of fires and refrigerators appear to be keeping up.

HEAVY-OIL ENGINES

The claim made by the Diesel Engineers' and Users' Association in its annual report (reviewed in this issue) that the conditions under which heavy-oil engines often operate are unfavourable to secure the best results is borne out by analysis of individual station performances in relation to load factor. Many such stations serve the useful function of peak lopping at the cost of higher fuel consumption/kWh, thereby tending to improve the thermal efficiencies of larger steam stations. Repairs and maintenance on the whole seem not to go up appreciably with longer running periods. In this respect mechanical-ignition engines make a particularly good showing.

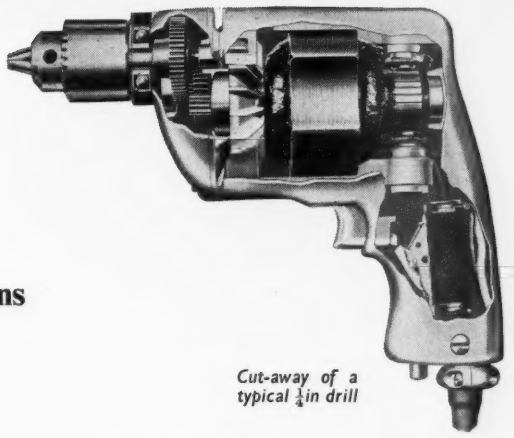
Season's Greetings

We extend to all our readers our best wishes for Christmas and the coming year, hoping that all will share in the prosperity which must attend our ever-expanding industry.

Portable Electric Tools

By M. G. TRESTRAIL, A.M.I.M.I.

A Review of Industrial Applications



Cut-away of a typical ¼in drill

SINCE the war the demand for portable electric tools has greatly increased. There are, perhaps, two main factors which account for this increase; viz. the desire of managements for equipment to speed up production with the minimum of expense, and also widespread acceptance of them by the worker on the shop floor.

Portable electric tools for industry include drills with capacities ranging from ¼in to 1in, screwdrivers for wood screws and nut-running, sanders for cleaning up castings and welds, and removing rust and for smoothing wood, portable grinders, saws for wood cutting and for metal slitting, electric hammers, i.c. engine valve reconditioning equipment, and bench grinders. Although the last items are mainly fixed to benches as permanent installations, they are classified generally as portable tools.

All the items listed above, with certain exceptions, are driven by series wound a.c./d.c. universal motors operating at high free-armature speeds ranging between 10,000 and 24,000 r.p.m. These are average speeds, the designed r.p.m. for a particular tool being based on its requirements and size, and again, generally speaking, the smaller the tool, the higher its armature speed. This is necessary so that the tool can develop sufficient power, but to provide good starting and stalling torque a reduction gear train is incorporated within the tool casing.

TABLE

Drill capacity	No-load spindle speed, r.p.m.
¼ in.	1,700 to 2,500
⅜ in.	600 to 900
½ in.	400 to 650
⅝ in.	350 to 550
¾ in.	300 to 450
⅞ in.	250 to 375
1 in.	225 to 350

Although portable tools must of necessity be light in weight and well balanced, they also must be powerful and capable of standing up to considerable abuse in service, and their motor design is such that they can be heavily overloaded for short periods. Naturally, this type of treatment should be deprecated, and the operator would be well advised to select a tool that is over- rather than underpowered. Although its initial cost will be higher than that of a smaller unit, its service life will be much greater, and in the long run it will probably prove to be the cheaper tool.

Unfortunately, for a number of applications a large unit would prove to be either awkward to handle or its speed might be too low, and in such an instance the user should strike a balance, bearing in mind that the greater the speed of the motor the less torque there is available, thereby increasing the possibility of stalling. Best results with portable electric tools are achieved when their motor operating speeds do not drop below 60 per cent of their no-load or free speeds. The table shows the relationship between drill chuck capacities and no-load spindle speeds. It will be seen that an average speed for a ¼in drill, which is an exceedingly popular tool, is in the region of 2,000 r.p.m.

In addition to the series wound universal motor there are two further types of motor suitable for tools of this nature. One is the single- or three-phase induction motor which will generally only operate from a power supply of 50 c/s. The design of the motor is such that it will rotate at a constant speed of either 1,500 or 3,000 r.p.m. with only a small drop at full load. Motors of this type are used mainly for bench grinders.

The second motor is the high-frequency three-phase type and operates from a supply frequency of 200 c/s. It maintains a constant speed under variable loads until stalling point is reached. High frequency, or as they are termed in America, " high cycle " tools have extremely high power-to-weight ratios, and as they have neither brush gear nor wound armatures, using only a solid rotor and heavily insulated stator, their maintenance problems are of a very minor nature. Trouble, when it does occur with these machines, usually takes the form of the motor single or double phasing, owing to either a defective switch, cable break, or faulty fuses, the last being the most common cause. The only other maintenance problems which can arise are purely mechanical, such as worn or defective reduction gears or bearings. Tools powered with this type of unit are for specialist work, generally of a continuous production nature (motor vehicle manufacture is a good example), and as equipment in the form of frequency changers is required, installation costs are high. In addition, as they are not produced in the same volume as universal type portable electric tools, the initial cost is also high.

Construction

A cut-away view of a typical portable electric tool, a ¼in drill, is shown. The carcase of the unit consists of a light alloy die casting and contains the field windings, armature, and brush gear. Underneath the casing is a pistol-grip type handle in which a trigger on/off switch is carried. Leading from the handle is a three-core cable. Spigoted on to the front end of the field casing and attached by three set screws is the gear casing in which the reduction gears are mounted. In this particular machine they are compounded, the teeth being straight cut. The drill spindle which protrudes through the front end of the casing is carried by a ball type journal bearing at the front and a needle roller bearing at the rear. All other bearings in this machine are of the ball type, including those for the

A 1½in electric hammer boring a hole in a concrete pipe. The tool delivers 2,300 blows per minute to the bit which is rotated by means of the cranked lever

armature. Attached to the drill spindle is a three-jawed, geared type chuck.

In the cut-away illustration, the cooling fan can clearly be seen. This draws in air through a series of small holes drilled in the commutator inspection covers mounted on either side of the tool above the pistol grip, forces it through the motor, and expels it through ducts cast in the motor casing behind the gear case.

The majority of portable electric tools follow this type of construction but with certain variations. For example, although a pistol type grip is suitable and convenient for small drills, as it allows the operator to use only one hand, larger models are generally fitted with closed end or spade type handles, particularly if there is any overhung weight. This type of handle is also more suitable for saws. On ¾in and 1in heavy duty drills, side and pipe handles are fitted so that the tool can be more easily handled. On the larger drills, Morse taper sockets can be supplied if required instead of a chuck. Grinders and sanders are fitted with straight end handles so that operators can maintain a steady downward thrust between the work and the outside diameter of the grinding wheel or on the face of the sanding disc. An auxiliary side handle fitted at the gearcase end of the tool is also provided to allow good control when the tool is in use.

The switchgear of portable electric tools should be readily accessible. Generally, switches are of the instant release type, but a locking pin is provided so that the tool can be operated continuously. In the interests of safety, saws are not provided with switch locking pins. Portable grinders and sanders are fitted with plunger type switches, generally situated at the front end of the tool handle. So that they cannot be accidentally knocked on, a shroud is formed in the light alloy casting, and surrounds the switch button.

Within recent years another phase of portable electric tool production has begun. Owing to the high cost of living following the war, and the large number of semi-skilled personnel released from the services and now owning houses, the modern trend is for householders to tackle many repairs and jobs which fifteen years ago would have required a tradesman to handle.

Portable electric tool manufacturers were quick to realize that a very large market existed for cheap electric drills which could be converted by means of inexpensive accessories into units capable of sawing, sanding, polishing, wood-turning, and grinding. To-day, this home handyman equipment has reached such popularity that a large proportion of the portable electric tools manufactured in this country caters for these requirements.

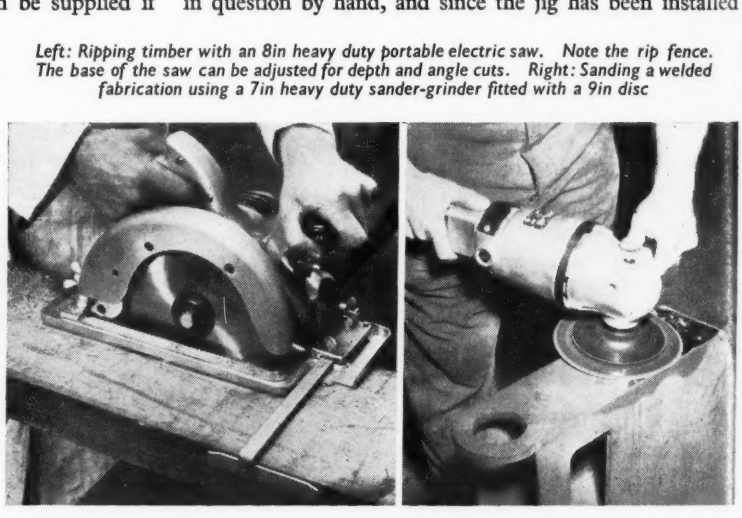
Tools designed for this market are not continuously rated machines, and although they are manufactured to the same high standards as their industrial counterparts, they are fitted with lower powered motors, plain bearings and, in the majority of cases, gearless chucks, thus reducing their initial cost considerably.

Tool Ratings

From the foregoing it will be seen that three main types of tools are available, heavy duty, standard, and light. The first are machines for use on heavy engineering projects and in shipyards, railways, fettling shops and applications where reliability and lengthy service are the main factors, price being of secondary importance. Tools of standard rating are designed for use in maintenance work and general workshop applications where continuous production requirements are not called for, whilst those in the last category are primarily for home workshops and part-time or jobbing craftsmen. The range of portable tools available is therefore so wide that there can hardly be any industry in which their use would not be advantageous.

The uses to which portable electric tools are put are many and varied. In fact, there is possibly no other equipment which has such a wide range of applications. For example, a ¼in drill can be used for assembly work in a radio or light engineering works, or it could be operated with equal success in a shipyard or foundry. To the writer's personal knowledge, there is at least one commercial vehicle manufacturer employing 42 ⅜in heavy duty drills, ganged together in a jig and used for drilling chassis frames. This work was originally carried out in the works in question by hand, and since the jig has been installed

Left: Ripping timber with an 8in heavy duty portable electric saw. Note the rip fence. The base of the saw can be adjusted for depth and angle cuts. Right: Sanding a welded fabrication using a 7in heavy duty sander-grinder fitted with a 9in disc



the chassis frame production rate has been increased by more than three times. Another application that comes to mind is that of removing the pituitary gland from pig carcases by means of a ½in drill driving a hole saw. The saw is fitted with a central ejector, and after removal of the saw from the carcase, the gland is ejected. It is subsequently used for the production of cortisone. A third example of drill applications is the use of a 1in heavy duty unit in sandpits for drilling shotholes before blasting. The speed of the operation is such that one man can place shotholes ten times more quickly than it is possible to do so by hand.

Although portable drills are essentially hand-held tools, it is possible to convert them into bench or pedestal machines by using a stand. Radial arms for wall or pedestal mounting are also available, thereby increasing the uses to which a tool can be put. Other attachments for industrial portable drills include grinding wheels, wire brushes, and hole saws. The last-named enable large holes of up to 4in diameter to be cut in sheet metal, wood, bakelite, plastics, porcelain, cast iron, and alloy steels. Apart from cutting wood, portable electric saws can be fitted with abrasive discs or metal cutting blades, thus adding to their usefulness. They are capable of operating 6, 8 or 9in diameter blades, and as their base plates are adjustable, it is possible to make depth or bevel cuts. Two-pole, instant release, trigger switches are fitted, and spring-loaded blade guards are normally specified. Saw reduction gears, which are of the helical type, are grease lubricated only, so that a unit can be inverted and used as a saw bench without any risk of oil spillage.

In many workshops a demand exists for portable electric sanders. These tools are extremely useful for the rapid sanding down of wood, stone, tile, or metal, and they can be fitted with wire cup brushes or planing heads to remove scale or paint from metal and to surface heavy timbers. A typical tool of this type has a no-load spindle speed of 4,200 r.p.m., is fitted with a 7in rubber moulded pad and weighs 14¼ lb.

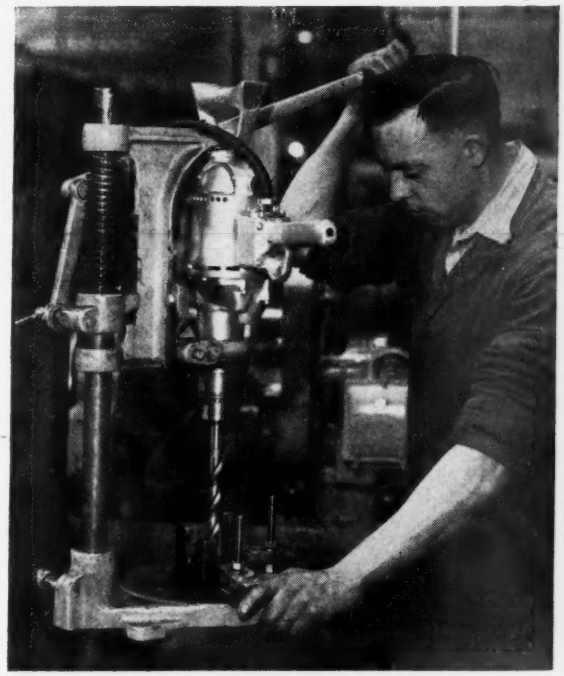
New Type Abrasive Disc

Within the last eighteen months or so a new type of abrasive disc has made its appearance on the British market. Known as a depressed centre, resin or nylon bonded cutting-off wheel, such discs are available in diameters varying from 7 to 9in, and in different thicknesses. The advantages put forward for these new discs include exceptional wearing properties, great resistance to breakage, and the ability of one wheel to notch, rough and finish grind a wide variety of materials ranging from cast iron to marble. Some typical applications for these discs include the cutting off of gates and risers on castings, cleaning down flame-cut edges of steel plates, cutting off angle iron, cutting sheet metal, cutting through limestone, granite and other stones, and removing rust and scale from heavy structures.

These wheels do, however, require high rotational speeds, and powerful tools to operate them, and in practice it has been found that portable electric sanders such as were in existence were not suitable for satisfactory operation. Therefore, new sanders are finding their way into industry designed for use with these discs. These new tools have motors capable of developing the power required and of giving the high speeds necessary, which range from 5,000 to 8,000 r.p.m. Advances in metallurgy have also made it possible for these tools to be as light as or even lighter in weight than existing sanders on the market.

To ensure maximum reliability, portable electric tools should receive regular attention and maintenance. Unfortunately, this is the exception rather than the rule, because owing to their simplicity and ease of operation, they are frequently used by semi-skilled labour, which has little or no regard for such matters. Although it is difficult to lay down definite intervals for service, as this depends very largely upon the type of work a tool is used for, if operating conditions are hazardous and the tool is in constant use, it would be as well to check the equipment every week.

One of the most important items to receive attention should be the earth wire. A "Megger" test for earth continuity is not sufficient, because if the wire is partially worn through and only two or three strands are intact, the reading will appear satisfactory. Therefore, a heavy current (25-30 amperes) at low voltage should be passed through the conductor for approximately ten seconds. Should the wire be partially broken, the high current will melt the few strands remaining. The same current should



A ¾in heavy duty drill mounted in a vertical stand

be passed from the tool casing to the earth pin of the plug, thereby ensuring that the power plug connections are in working order and tight. The power cable insulation should be maintained free from grease and oil which would rot the covering, and the cable should be kept free from sharp curves or kinks. It is bad practice to drag the tool by means of the cable.

Brush gear should also receive weekly attention, as records show that approximately 75 per cent of all tool breakdowns can be attributed to lack of brush gear care. Universal motors which operate at high speeds wear their brushes out more frequently than low speed machines, and they should be replaced when reduced to one-third of their initial length, otherwise the spring pressure will be considerably decreased. New brushes should be a good sliding fit in their holders, otherwise they will not contact or properly bed down on the commutator, thus causing loss of power and sparking. It is also important to ensure that brush spring pressure is sufficient to maintain the brushes in good contact without any undue sloppiness. It should be such that the brush contact pressure with the commutator

is between 2 and 2·5 lb per sq in. When the brushgear is removed, the commutator condition can be examined. If greasy, it can be wiped with a clean rag dipped in petrol, but if it is rough or uneven, the armature should be removed and the commutator cleaned down with fine sandpaper. If this treatment does not appear to be sufficient, then the commutator should be set up in a lathe and skimmed down until it is perfectly free from pits and blemishes. After turning, the mica insulation should be undercut. This should only be carried out if it was originally undercut, as certain motors have flush mica commutators. Whilst the armature is out of the motor, any connections that may have been thrown loose should be resoldered.

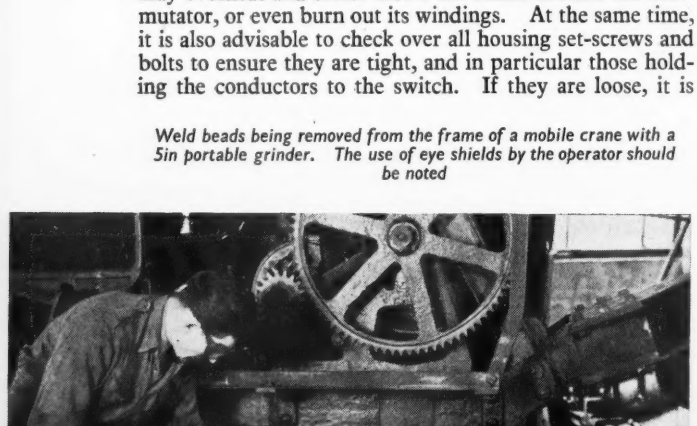
Apart from weak brush springs and brushes not making contact with the commutator, arcing can be caused by undercut mica type commutator brushes being used on a flush mica commutator causing heavy brush wear. Commutator wear will also be abnormal if flush mica type brushes are used on an undercut mica commutator. In addition to arcing, vibration and commutator wear can be caused by excessively worn armature shaft bearings, leading to the setting up of lateral play in the shaft.

Dust Build-up

Another cause of breakdown can be attributed to brush dust mixing with oil vapour inside the machine and settling on the brush gear and armature windings. If this is not regularly cleaned away, it will continually build up until it can permit a current leakage to pass to the tool casing. In some cases, it can also cause insulation breakdown in the armature windings. To overcome metallic and carbon dust build-up, the interior of the tool should be blown out every week with a compressed air jet.

In addition to the powder formed by brush wear, many tools are subject to large quantities of dust and grit in grinding and sanding applications. This often covers the machine and care must be taken to ensure that the ventilating ports do not become clogged, otherwise the tool may overheat and either throw the solder around the commutator, or even burn out its windings. At the same time, it is also advisable to check over all housing set-screws and bolts to ensure they are tight, and in particular those holding the conductors to the switch. If they are loose, it is possible for them to work free through vibration, and to cause an internal short circuit. While the switch connections are being checked the earth wire retaining screw should also be examined and, if necessary, retightened.

Weld beads being removed from the frame of a mobile crane with a 5in portable grinder. The use of eye shields by the operator should be noted



Motor and switch insulation resistance should be checked monthly by means of a " Megger " tester, and if the reading obtained is below 0·5 megohm, the motor components should be examined for defects. Very often, the insulation resistance can be improved by clearing the defective insulation and coating the area with shellac varnish. The windings can also be cleaned with a brush dipped in petrol. They should then be thoroughly dried by an air-gun and treated with insulating varnish, but care should be taken to ensure that the varnish used will not attack the insulating enamel on the wire. Should a switch prove to be faulty, it should be renewed, and no attempt made to repair it.

At intervals of six months, the tool should be stripped down and all components cleaned and examined for wear. The gearcase should be wiped free of grease and cleaned out by flushing with petroleum spirit. Fresh grease should then be applied, the quantity depending upon the size of tool. The grease should cover the gears, but over-greasing must be avoided, as otherwise it will expand when the motor warms up, and possibly be forced through the armature spindle and bearings into the motor. Armature bearings of industrial tools are generally of the grease-sealed type, and once fitted need no attention. Domestic type units with plain bearings, however, can be lubricated occasionally with a few drops of good quality sewing machine oil. Certain machines are fitted with sintered, self-lubricating bearings, but in time the oil does evaporate and needs replacing. Over-oiling should be avoided, as otherwise the armature and field windings may become soaked and lubricant may be flung on to the commutator. The above work can be carried out at the same time as the machine is stripped down for its six-monthly overhaul.

Safety Precautions

Portable electric tools are manufactured to high standards of workmanship and if correctly operated and maintained will give little or no trouble. The most important precaution to take when installing equipment of this nature is to ensure that it is properly earthed and all British portable electric tools are supplied to the user with the earth wire covered in a green coloured insulator.

If the machine is to be operated under damp conditions, and consequently the risk of electric shock is greater, a 110 V tool is essential, fed from a double-wound transformer. The secondary winding of the transformer is centre tapped and connected to earth, the breakdown voltage between the tool casing and earth thus being 55 V. The use of 110 V tools under any workshop conditions is, on the whole, desirable.

It is, of course, hardly necessary to mention that no portable electric tool should ever be operated from a domestic light fitting unless the machine is properly earthed. If the tool is to be operated some distance away from a power plug, an extension cable should be used.

Operatives using portable electric tools should be fully aware of the correct accessories and attachments available for use with their equipment. For example, those engaged on portable grinders should wear masks to protect their eyes and respiratory organs. Abrasive wheels should be properly dressed, and should run true on their spindles. Wheel guards should be fitted to all high-speed machines, screwdrivers operated with the correct bit, drills should use only the size of twist drill designed for the chuck, and portable saws, or for that matter any portable electric tool, should not be adjusted unless the power supply is switched off at the mains.

Railway Electrification in Spain

Recent Progress on the National System

By B. K. COOPER

WORK recently completed in connection with the Spanish National Railways electrification programme has brought the mileage worked by electric traction up to a total of 595. The administration's general plan of electrification was drawn up in 1946 and covers the conversion of some 2,800 miles. It is divided into stages, the first stage, now in progress, covering 884 miles. Its scope embraces certain lines in areas hitherto worked exclusively by steam, and important extensions to routes which have been electrically operated for periods up to 33 years. Most of the work will be at 3,000 V d.c., but 1,500 V will be retained on extensions to the line to the French frontier at Irun which is already electrified at that voltage.

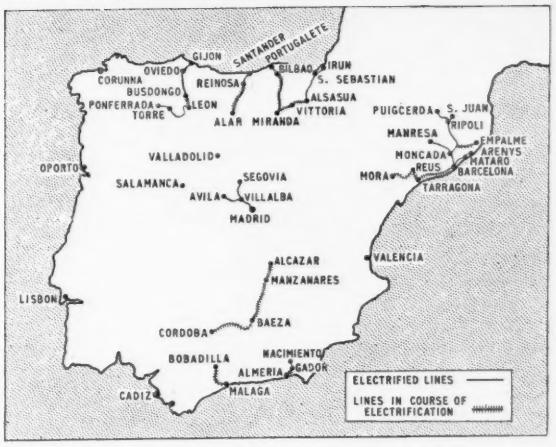
Railway electrification in Spain began in 1911 on the former Great Southern of Spain Railway between Nacimiento and Gador (19½ miles) in the Province of Almeria. Power was supplied by a steam power station with a capacity of 945 kVA, the line being operated at 6,600 V, three-phase, 25 c/s. Later, the power station capacity was increased by the addition of a 650 kVA diesel-generator set. A light "tramway" type overhead system is installed and the motive power consists of seven 320 h.p. locomotives with induction motors. This electrification is now being extended to the coast at Almeria, and the purchase is planned of four eight-wheel locomotives. A frequency-convertor substation has been built at Santafé to enable the line to be supplied from the public electricity system, the steam power station being retained as a reserve.

Conversion of Northern Lines

In 1922 the Norte Railway Co. began the electrification at 3,000 V d.c. of the 38 miles between Ujo and Busdongo, over which coal from the important deposits in Asturias is carried to the rest of Spain and where severe gradients limited the capacity with steam traction. Recently, this electrification has been extended over the 34 miles from Ujo to Gijon. Power is obtained at 30 kV, three-phase, from a supply undertaking. On the original section there are two motor-generator substations, but mercury-arc rectifiers have been installed on the extension to Gijon.

The overhead system is a single catenary supplemented by positive feeders of 0·15 sq in cross section and a negative cable of the same section which is additional to the rail return and is connected to the track at intervals of about 1,100 yd. The grooved copper single contact wire is of the same cross-section as the feeders.

In the same region of Spain the 80 miles between Leon and Ponferrada also carry heavy coal traffic over difficult gradients, and the 13½ miles from Torre to Branuelas on this section were electrified temporarily at 1,500 V d.c. in 1949, so that existing locomotives could be used. Early



Lines of the Spanish National Railways already electrified and in course of electrification under the first stage of the electrification programme

this year the whole line was converted for operation at 3,000 V d.c., and work then proceeded on electrifying at this voltage the 33 miles between Leon and the earlier electrification at Busdongo.

As a result of the economic success of its Ujo-Busdongo electrification, the Norte company in 1926 began to electrify the Barcelona-Moncada-Manresa section (40 miles) and the Moncada-San Juan section (66 miles), both at 1,500 V d.c. At about the same time work was begun on electrification at the same voltage between Alsasua and Irun (65 miles) in order to increase the speed of heavy passenger trains running between Madrid and the French frontier. On these sections the substations are spaced at intervals of between 11 and 15½ miles. Each rotary convertor group consists of two 750 kW, 750 V machines connected in series on the d.c. side. From one to three groups are installed at substations according to the power demands. The catenary consists of a single suspension cable supporting two contact wires of 0·15 sq in cross-section, without additional feeders.

Stage 1 of the electrification programme now in progress includes extensions of the Alsasua-Irun scheme by conversions from Alsasua to Miranda (47 miles) and from Miranda to Bilbao (64½ miles). These will be carried out at 1,500 V d.c., using equipment from the Barcelona area electrifications, which will be converted to 3,000 V.

Two other 1,500 V electrifications carried out by the Norte system are those from Ripoli to Puigcerda, in Catalonia (33 miles), and from Bilbao to Portugalete, in Vizcaya (16¾ miles). This railway was also studying electrification from Madrid to Avila and Segovia, but the Spanish Civil War put a stop to the project. It was resumed and completed after the civil war by the newly-formed Spanish National Railways. This electrification is also operated at 1,500 V d.c. and consists of the line from Madrid to Avila (79½ miles) with its branch from Villalba to Segovia (48½ miles). There are eleven substations in all, each equipped with two groups of two 750 kW, 750 V rotary convertors connected in series on the d.c. side similar to those of the Barcelona and Irun sections. Current is collected from twin overhead contact wires with a cross-section of 0·15 sq in which are suspended from a single catenary. Connections are made to the contact wires at intervals of about 109 yd from a copper feeder with a cross-section of 0·47 sq in or 0·28 sq in, according to the power demands on different sections.

In addition to the new work already mentioned, the first

English Electric 3,600 h.p. 3,000 V locomotive hauling a goods train on the Ujo-Busdongo section of the Spanish National Railways

stage of the electrification programme embraces the following lines: Barcelona area extensions, 246 miles; Cordoba-Alcazar, 211 miles; Malaga-Bobadilla, 45 miles; and Reinosa-Alar, 31 miles.

Locomotives

To work newly-electrified lines orders have been placed for 163 Co-Co locomotives of 3,000 h.p. Sixty-three of these have been supplied by the English Electric Co., Ltd., and are operating on the Busdongo-Gijon and Leon-Ponferrada sections. Alsthom has supplied 60 and has collaborated in the construction of 20 similar units in Spain; while 20 more were built in Spain and supplied with electrical equipment by the Westinghouse Company. Further orders have been placed with Swiss and Spanish firms for 143 three-coach suburban multiple-unit sets, each consisting of two motor coaches and a trailer.

On the 1,500 V Barcelona-Manresa-San Juan and Alsasua-Irun sections three types of locomotives are in service. Series 7000 and 7100 locomotives are rated at 1,800 h.p. and are identical electrically. Both have two three-axle motor bogies, but the 7100 class is provided also with a non-motored guiding axle at each end in order to reduce the driving axle load to 15 instead of 17 tons. Both have regenerative braking. The Series 7200 locomotive consists of twelve 2,860 h.p. units for semi-fast traffic on the Alsasua-Irun line. The traction motors are carried in the frames of the two three-axle motor bogies and drive through Brown-Boveri flexible transmissions. A two-axle guiding bogie is pivoted from each motor bogie, and regenerative braking is available.

On the Madrid-Segovia line the motive power consists of 24 locomotives of the Series 7400, which is similar to the Series 7000 but of 2,400 h.p.; 12 locomotives of Series 7500, similar to Series 7200 but of 3,410 h.p.; and one 3,120 h.p. locomotive, No. 7301. The last-named is powered by two three-axle motor bogies in which each axle is driven by two motors, and there is a two-axle guiding bogie at each end.

Motor coach stock on all the 1,500 V lines is of uniform design, the basic element being a permanently-coupled motor coach and trailer combination in which the electrical equipment is divided between the two vehicles. Each of the four axles of the motor coach is driven by an axle-hung motor. Control is electromagnetic with automatic acceleration, a rate at starting of 1·3 m.p.h. per sec being obtained. The maximum speed is 56 m.p.h. Compressed air brakes on all vehicles are supplemented by rheostatic braking on the motor coaches.

By improving speeds over heavily graded sections, electrification has already enabled long-distance travel between important cities to be accelerated substantially. The Madrid-Corunna journey, passing over the Leon-Ponferrada electrified line, has been shortened by 1 hr 45 min, while the Busdongo-Gijon electrification has enabled the time from Madrid to Gijon to be reduced by 1 hr. Similarly, one heavy night express from Santander makes the journey to Reinosa over gradients as steep as 1 in 43 in one hour less than with steam traction. The increased capacity of the electrified lines for handling goods traffic is of major importance to the economy of the country, particularly in the north-west, where industrial expansion and development are proceeding rapidly. Even the short preliminary electrification between Torre and Branuelas on the Leon-Ponferrada line enabled the daily tonnage of goods hauled over this section to be increased by over 36 per cent.

Proton Linear Accelerators

IN collaboration with the United Kingdom Atomic Energy Authority, a 0·5-50 MeV proton linear accelerator is being designed and manufactured by the Metropolitan-Vickers Electrical Co., Ltd., for installation in the Atomic Energy Research Establishment at Harwell. This is the first section (described as the "pilot section" in the recently issued report of the U.K.A.E.A.) for a 600 MeV accelerator, but it is understood that a decision to proceed with the complete plant has not yet been made. Metropolitan-Vickers is also building an almost identical accelerator for the European Council for Nuclear Research ("CERN") at Geneva.

The proton accelerator for Harwell will consist of three resonant cavities, respectively 20, 40 and 40ft in length. The first 20ft will accelerate protons from an injector to an energy of 10 MeV. Power is to be provided by triode amplifiers driven at a controlled frequency, special valves having been developed for this purpose by the U.K.A.E.A. Grid focusing will be employed in the first cavity, but the remainder of the machine will use magnetic alternating-gradient focusing in order to extract a higher current beam. In this method of focusing a quadripolar lens is included inside each drift tube, and these lenses are arranged so that the focusing in one plane and de-focusing in a plane at right angles are interchanged on alternate drift tubes; this produces an overall focusing in the manner now employed for large synchrotrons.

For the Harwell equipment, which will produce protons at an energy of 50 MeV, radio-frequency power will be supplied to each cavity in pulses of 400 μ sec duration at a maximum recurrence rate of 50 per sec; the injector is to supply a peak current of 5 mA at 0·5 MeV, and, as 0·5 mA is expected to be trapped in phase and accelerated within the machine, a high output current may be expected. The equipment for Geneva will operate at a much lower duty cycle, as it is to be used as an injector for the new 25 GeV proton synchrotron to be built there.

VIEWS on the NEWS

By REFLECTOR

A SPEAKER at the annual dinner of the Nottingham Society of Engineers cast doubt upon the claim of learned societies to be educational. Only six people in a hundred, he said (as reported in the *Guardian-Journal*), attending technical lectures understood what the speaker was talking about. If he meant public technical lectures that may have been true but surely the educational function of learned societies is primarily for the benefit of their members who may be presumed to have a better understanding than the public of the subjects presented. The same kind of criticism is constantly being levelled at the British Association for the Advancement of Science and maybe in this case it can more easily be justified. One purpose of the B.A. is to acquaint scientists in various fields (as well as the public) with what is going on in the departments of science other than their own. Too often, however, the language of one section is incomprehensible to those outside. It is not always easy to express in simple terms the significance of scientific development in a highly specialized field.

* * *

I have always believed that one of the "headaches" of the Central Electricity Authority is the time which elapses between the placing of contracts for power stations and their completion. It may be otherwise in some parts of the country for the *Derbyshire Advertiser* reports that the president of the Derby Society of Engineers at a dinner of the Derby Electrical Society "spoke of huge power stations which sprang up like mushrooms in the night."

* * *

I referred last week to the many electrical toys available this Christmas and commended this way of inculcating the electrical idea. I have now been shown a child's birthday greetings card (not of electrical origin) in which the theme of a number of pictures, accompanied I am afraid by atrocious puns ("May Fortune 'pylon' all that is best"), is entirely electrical. A teddy bear appears in all of them but I am sorry to see one picture showing him in too-close proximity to an unguarded electric fire and wonder about the wish—"May you be in your 'element' to-day."

* * *

Commenting upon the abortive House of Commons debate on noise, the *Economist* rightly says that the cost of reducing noise is obviously very great. But when it expresses the opinion that "electric trolleys are quieter than buses, but more costly to operate" I think it should go more closely into the figures. The experience of most transport authorities with mixed systems is, I believe, that the trolley-buses are more profitable to operate.

* * *

A Weymouth correspondent (Mr. E. S. Weeks) has sent me a cutting from the *Dorset Daily Echo* reporting a meeting of the management committee of the Herrison Hospital, Dorchester. At this the chairman said that one of the alternator sets which was supplying electricity in the hospital until a few months ago was being presented to the Science Museum, South Kensington. They had been told by the Museum authorities that this was the oldest generator in the country still in use. The chairman then mentioned that the complete re-wiring of the hospital had nearly been finished. Unfortunately at this point the lights went out and, the report concludes, "electricians were unable to restore the current until the end of the proceedings."

* * *

In the *South Wales Argus* last week I came across the following sad little story:—

"On the corner of a street in the Gellicrug district of Abertillery there were two lamps, one gas one electric, their standards shoulder to shoulder. For public lighting in Abertillery was in a state of transition — electricity moving in and gas moving out. For weeks the two lamps shone in bright harmony, and, indeed, it was just about the best lit corner in the town. However, that splendid state of affairs could not last; along came the gas men and beheaded their out-of-favour standard. Unhappily the electric lamp failed soon afterwards."

* * *

"Television Newsletter" produced by Pye, Ltd., says:—

"America provides its viewers with a novel 'close down' item from a TV station in Manhattan. A pretty model, scantily clad, performs a retiring scene in which she delicately goes to bed, after which viewers are themselves tempted to sleep with pictures of sheep jumping over a fence."

Some quite un-ovine British television programmes have tempted me to sleep.

* * *

Sixty years ago (in the issue of 27th December, 1895) the *Electrical Review* indulged in speculation about electricity's future. The inevitability of the use of electricity for lighting was taken for granted but it was thought that electric heating would be beyond the reach of the poor man. It went on:—

"Our strongest hopes of the future are built upon the further application of electricity to the universal working of light railways and tram lines; to the extraction of metals from their ores; to the use of electric motors in textile factories, engineering workshops and in the homes of working mechanics; to the cheap production of aluminium, and in metallurgy generally; to the eventual production of an ideal secondary battery, which will enable us readily and economically to store electrical energy during the period of light load, and to drive tramcars; and to many uses in connection with chemistry. It has been urged that the embryo Kelvin, Kennedy, Preece or Hopkinson should be primarily a mechanical engineer; we would go further and suggest that a good knowledge of chemistry will be found of equal importance to the electrical engineer of the next decade."

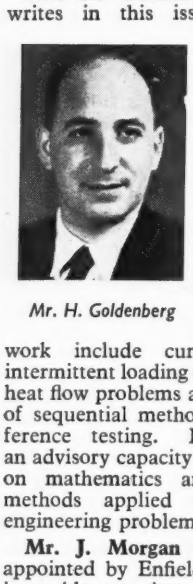
PERSONAL AND SOCIAL

News of Men and Women of the Industry

Sir Edward Bullard, F.R.S., is retiring on 31st December from the post of director of the National Physical Laboratory which he has held since 1950. The appointment of his successor will be announced later and in the meantime **Dr. R. L. Smith-Rose** is to be acting director as from 1st January. Dr. Smith-Rose is now director of radio research in the Department of Scientific and Industrial Research.

Mr. L. H. Finedon, formerly commercial sales manager of Remploy, Ltd., has been appointed sales director, with effect from 1st December.

Mr. H. Goldenberg, M.Sc., who writes in this issue on "Laplace Transformation," obtained the B.Sc. Physics and the B.Sc. Special Mathematics degrees at Imperial College, London, in 1947, and the M.Sc. Mathematics degree in 1951. He joined the Electrical Research Association in 1947 and his fields of work include current rating and intermittent loading of cables, transient heat flow problems and the application of sequential methods to radio interference testing. He also acts in an advisory capacity to the E.R.A. staff on mathematics and computational methods applied to physical and engineering problems.



Mr. H. Goldenberg

Mr. J. Morgan Blades has been appointed by Enfield Cables, Ltd., as its resident engineer in Canada. Mr. Blades, who takes up his appointment to-day (Friday), will be in Montreal. For the last six years he has been with the Hydro-Electric Power Commission of Ontario.

It is announced that **Mr. W. E. Gardner,** B.Eng., has been appointed managing director of Enfield Cables (Australia) Pty., Ltd., as from 3rd December. Mr. Gardner has spent all his life in the cable industry and for many years was associated with Siemens (Australia) Pty., Ltd.

Dr. W. G. Marley, of the Health Physics Division of the Atomic Energy Research Establishment, Harwell, left for Stockholm on 10th December. He will give four lectures, which will form part of a five-week course on "Health Physics" held under the auspices of the World Health Organization in collaboration with the Swedish authorities. On his return Dr. Marley will break his journey at Copenhagen in order to have talks with the Danish Radiological Protection Committee, at the invitation of the Danish Health Ministry.

R. B. Pullin & Co., Ltd., announce the appointment of **Mr. R. K. Deane** as production controller, with effect from 1st December. Mr. Deane was previously on the production management staff of the Wilkinson Sword Co. and prior to that spent many years in the aircraft industry in both the United States and New Zealand. With effect from the same date **Mr. H. R. Botting** is taking up the position of chief buyer.

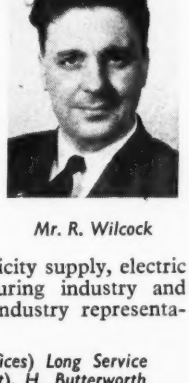
Mr. R. K. Deane

Mr. T. P. Hughes, M.A., Ph.D., has been appointed director of the Tube Investments Research Laboratories at Hinxton Hall, Cambridge. **Dr. F. P. Bowden,** F.R.S., is the chief research consultant to Tube Investments. Dr. Hughes was head of the Chemistry Department and subsequently chief superintendent of the Rocket Propulsion Department of the Royal Aircraft Establishment before joining Tube Investments.

The second annual dinner of the **Ediswan (London and District Offices) Long Service Association** was attended by seventy members, honorary members and guests at the Horse Shoe Hotel, London, on 2nd December. The chairman was Mr. D. F. Botwright (Publicity Department), who has been re-elected to the chair for 1956. Long service awards were presented by the president of the Association, Mr. H. Butterworth (managing director), to four members, Miss Whitwell (Leicester), Mr. A. G. N. Dixey (company secretary), Mr. C. W. Harvey (Cardiff) and Mr. E. S. Speller (London). At the same time, at local functions, awards were made to six other members, Miss Croydon and Mr. Blackburn (Bristol), Miss Leach and Mr. Curtis (Southampton), Mr. Meston (Newcastle) and Mr. Tranter (London).

Mr. R. Drinkwater has been appointed turbine specialist engineer with the Brush Electrical Engineering Co., Ltd., Loughborough, in succession to **Mr. R. D. Taylor,** who is now the company's London branch manager. Mr. Drinkwater received his technical education at the Loughborough College of Technology, where he gained first-class honours in mechanical engineering. He had experience with the Central Electricity Authority on power station layout, with the English Electric Co. on steam turbine design, and with W. H. Allen, Sons & Co., of Bedford, before joining the Brush Co. some time ago.

Mr. R. Wilcock, whose article on "Modern Steelmaking" appears in this issue, gained the Associateship of Metallurgy at Sheffield University. Since 1948 he has been works metallurgist with Samuel Fox & Co., Ltd. This is the third article in a specially commissioned series which has been prepared by electricity supply, electric furnace manufacturing industry and steel production industry representa-



Mr. R. Wilcock

At the annual dinner of the Ediswan (London and District Offices) Long Service Association. Left to right: Messrs. F. E. C. Miller (vice-president), H. Butterworth (president), A. H. Adey (Birmingham district office manager), D. F. Botwright (chairman), V. J. Bainbridge (committee), and J. W. Ridgeway (vice-president)

tives dealing critically but constructively with the Battelle Report on the use of arc furnaces for the production of ordinary grades of molten steel in America, which was issued about two years ago.

Major E. H. W. Banner, T.D., has been elected chairman of the University of Birmingham Guild of Graduates, London Branch. **Mr. H. G. Foster,** editor of *Electronic Engineering*, is vice-chairman.

Mr. J. D. Bruen has been appointed manager of the new branch office of Tufnol, Ltd., which will open on 2nd January at Ellison House, Woodlands Terrace, Glasgow, C.3 (telephone: Douglas 5335). Mr. Bruen, who has represented Tufnol, Ltd., in Scotland since 1948, was educated at George Heriot's School and the Heriot-Watt College, Edinburgh. After serving an apprenticeship with Bruce Peebles & Co., Ltd., he went to sea as a marine engineer. He returned to the technical staff of Bruce Peebles before joining the northern area branch office of Tufnol, Ltd., as a sales engineer. During the last war Mr. Bruen served first as a staff officer in the Royal Engineers and later as a unit commander in the R.E.M.E.

Mr. J. D. Bruen

At the New Southgate works of **Standard Telephones & Cables, Ltd.,** Sir Thomas G. Spencer (chairman and managing director) welcomed twenty-five recently qualified graduates at a luncheon to mark the beginning of their industrial career. The young men come from all parts of the country. They include science, engineering and arts graduates from universities. They will all receive a comprehensive training course lasting one or two years. Most of this time will be spent undergoing practical training in different departments relating to their eventual engineering or administrative roles in the company. They will also be given a more general insight into industrial organization during a two months' course when they will visit the company's factories in London and the provinces, attending lectures, making tours and dealing with problems connected with the engineering, manufacturing, commercial and personnel sides of the company. Speaking at the luncheon, Sir Thomas said that he hoped they would take advantage of the new and exciting opportunities ahead.

The annual apprentice prize-giving of **Hoover, Ltd.,** was held on 14th December at the company's headquarters at Perivale, Middlesex. Mr. B. H. Dyson, general works manager, opened the proceedings and the chairman for the evening was a fifth year apprentice, Mr. R. Fowler. The prizes were presented by **Dr. D. M. Tombs,** who recently joined the company to direct its new research department. He gave a talk and demonstration to the boys based on some of his own researches. The prize-giving was followed by a play presented by the Hoover Apprentice Association.

Mrs. Jennifer Chimes (Blackpool) who was chosen Mazda "Queen of Light" for the year 1955/56 on Monday, 12th December, is pictured in company with the retiring "Queen," Miss Stephanie Howell (left) and Mr. V. C. H. Creer, the Mazda sales director

Mr. F. W. Halliwell, C.B.E., M.I.MechE., M.I.Prod.E., chairman and managing director of Gay's (Hampton), Ltd., has been re-elected president of the Gauge and Tool Makers' Association. **Mr. S. J. Harley,** B.Sc., M.I.Mech.E., M.I.Prod.E., chairman and managing director, Coventry Gauge & Tool Co., Ltd., has been appointed deputy president, and **Mr. L. E. Van Moppes,** director of L. M. Van Moppes & Sons (Diamond Tools), Ltd., has been elected chairman.

Mr. M. G. Trestrail, who writes in this issue on "Portable Electric Tools," studied at the College of Automobile Engineering, where he gained a first-class diploma, and subsequently joined C.A.V., Ltd., as a student engineer. After three years with this company he left to join General Motors, Ltd., at their London office. After a further three years he joined the technical editorial staff of *Motor Industry*. He is now employed by Black & Decker, Ltd., as Press officer to the company.

Mr. M. G. Trestrail

The North Staffordshire Electricity Branch of the National and Local Government Officers' Association has commemorated the name of the late Mr. Thomas Lockett, a member of the Association for over forty years and president of the branch from its formation until 1949, by investing a fund for the award of a Thomas Lockett Memorial Prize. The *Evening Sentinel* reports that the first award of the prize has been made to **Mr. J. H. Edwards,** of the North Staffordshire Sub-Area headquarters staff, Midlands Electricity Board.

Mr. J. H. Russell, works director, has been appointed deputy managing director of Hall & Pickles, Ltd., and **Mr. F. R. Robbins,** general sales manager, has been appointed sales director.

Mr. A. J. Shrosbery, A.I.E.E., Assoc.I.Mech.E., has been elected chairman of T. Clarke & Co., Ltd., and **Mr. G. A. Robinson** has been elected to the board.

Mr. L. Holland and **Mr. F. G. Rowland,** who for some years have been associated with Switchgear & Cowans, Ltd., have been appointed directors of the company. **Mr. Douglass Hewitt** has been appointed an additional director.

Sir Joseph Qualtrough, C.B.E., Speaker of the House of Keys, has been appointed chairman of the Isle of Man Electricity Board in succession to **Mr. J. R. Corrin,** who recently retired from the Legislative Council.

The annual general meeting of the British Association of Machine Tool Merchants was held on 13th December at the May Fair Hotel, London, when **Mr. E. Heliot** (Heliot Machine Tool Co.) was elected president of the Association for the ensuing year in succession to **Mr. A. V. Graves** (E. H. Jones (Machine Tools), Ltd.), who remains on the Council. **Mr. A. W. Bell** (H. Bell (Machine Tools), Ltd.) was elected vice-president and **Mr. E. J. F. Bradley** (Pidgen Bros., Ltd.) was re-elected hon. treasurer. Following the meeting a luncheon was held which was attended by a large number of members and their guests. The toast of the Association was proposed by Mr. F. J. Erroll, M.P. (Parliamentary Secretary, Ministry of Supply), and that of the guests by Mr. A. W. Bell (vice-president). Responses were made by the president and the Hon. Peter Remnant, M.P.

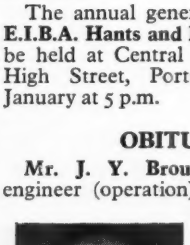
The annual dinner of the **I.E.E. South Midland Centre** will be held on 3rd February at the Grand Hotel, Birmingham, when the president of the Institution, the Lord Mayor of Birmingham, and other guests will be present. Applications for tickets (£1 7s for members and guests and

17s 6d for graduates and students) should be made by 9th January to Mr. E. H. Cox, Midlands Electricity Board, Mucklow Hill, Halesowen, near Birmingham.

The annual general meeting of the **E.I.B.A. Hants and Dorset Branch** will be held at Central Electricity House, High Street, Portsmouth, on 24th January at 5 p.m.

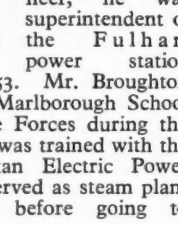
OBITUARY

Mr. J. Y. Broughton, generation engineer (operation) for the Western Group of power stations in the London Division of the Central Electricity Authority, died suddenly on 14th December aged fifty-nine years. Before his appointment as generation engineer, he was superintendent of the Fulham power station from 1950 to 1953. Mr. Broughton was educated at Marlborough School and served in the Forces during the 1914-18 war. He was trained with the North Metropolitan Electric Power Supply Co. and served as steam plant testing engineer before going to Fulham in 1926.



The late Mr. J. Y. Broughton

Mr. H. V. Pointon.—The death occurred on 14th December, at the age of fifty-nine, of Mr. Herbert Vincent Pointon, M.I.E. (India), F.R.S.A., managing director of Asea Electric, Ltd., and the Fuller Electrical & Manufacturing Co., Ltd. Mr. Pointon was educated at Battersea Polytechnic, and received his practical training with the Metropolitan Electric Supply Co., with which company he was later shift engineer. He joined Asea Electric, Ltd., in 1920 as technical assistant, and had held the positions of manager, printing trades department (1923-25), and general manager and chief engineer for India, Burma and Ceylon (1925-49), becoming a director in 1946 and managing director in 1949. Mr. Pointon was also a director of Asea Electric India, Ltd., and Asea Electric (Ireland), Ltd. He was a past-chairman of the Junior Institution of Engineers, a Justice of the Peace for Bombay, and hon. magistrate.



The late Mr. H. V. Pointon

Mr. E. L. Bagshawe.—The death is reported, at the age of seventy-nine, of Mr. Edward Leonard Bagshawe, C.I.E., O.B.E., D.S.O., who was with the Indian Telegraph Service for 34 years, having been chief engineer from 1925 to 1930.

Mr. James Albert Steeples, secretary of the Leicester Sub-Area of the East Midlands Electricity Board, died on 10th December at the age of fifty-seven. Mr. Steeples began as an office boy with the Leicester Corporation Tramways and Electricity Department in 1911, and with over forty-four years' service was one of the longest-serving employees of the Board.

Mr. E. F. Foster, M.Inst.F., for many years one of the senior sales representatives in the United Kingdom for George Kent, Ltd., died on 9th December at the age of fifty-six. Mr. Foster joined the company in 1915.

WILLS

Mr. T. Lawrie, C.B.E., general manager, North of Scotland Hydro-Electric Board, who died on 13th August last, left personal estate in England and Scotland valued at £14,710.

Mr. F. H. Crocombe, M.M., M.B.E., district engineer at Minehead to the South Western Electricity Board, who died on 18th August last, left £5,280 gross (£4,719 net).

Mr. C. Strafford, M.I.E.E., London agent and former manager of China Light and Power (1918), Ltd., who died on 15th September last, left estate in Great Britain valued at £15,283 gross (£15,158 net).

Mr. D. Sinclair, A.M.I.E.E., London representative of Andrew Chalmers and Mitchell, Ltd., electrical engineers, Glasgow, who died on 6th September, left personal estate in England and Scotland valued at £2,117.

Mr. C. A. Vandervell, director of Vandervell Products, Ltd., and other companies, who died on 30th August last, left £262,158 gross (£262,008 net).

Mr. E. P. Allam, retired electrical engineer, founder and director of E. P. Allam and Co., Ltd., who died on 8th May last, left £50,104 gross (£49,884 net).

Mr. J. Riley, founder of John Riley & Son (Electrical), Ltd., electrical wholesalers, Sheffield, who died on 12th July last, left £47,388 gross (£46,832 net).

Mr. H. L. Kirke, C.B.E., formerly assistant chief engineer, B.B.C., who died on 25th August last, left £11,091 gross (£10,991 net).

Mr. H. G. Morgan, manager of the Swansea branch of the General Electric Co., Ltd., who died on 12th August last, left £4,046 gross (£3,898 net).

Mr. A. Watson, assistant managing director of Stanton Ironworks, Ltd., who died on 22nd September last, left £8,997 gross (£8,754 net).

British Engineers' Association

The Chancellor of the Exchequer, Mr. R. A. Butler, C.H., M.P., was the principal guest and speaker at the annual luncheon of the British Engineers' Association, held on 14th December at the Dorchester Hotel, London. The president of the Association, Mr. W. K. G. Allen, was in the chair. Over four hundred were present and among those who had accepted invitations were diplomatic representatives from more than thirty Governments.

The president, expressing pleasure at the large number of diplomatic representatives present, said that it was particularly gratifying that, in the present period of keen competition, the prestige of British capital goods stood so high. The engineering industry was not, however, complacent; it recognized that manufacturers would only continue to secure business so long as they were competitive in quality, price and delivery. He hoped that the Chancellor would do all he could to ensure that the engineering industry obtained more steel.

Mr. Butler said that metals, machines and vehicles between them had contributed two-fifths of the total increase in industrial output between 1948 and 1954—to the benefit of the export trade, the growth of industry as a whole, and the country's defence programme. The members of the Association, as manufacturers of capital equipment, had been in the forefront of this expansion. The defence programme made a greater impact on the engineering industry than on any other, and on some sections it fell heavily. But taking it as a whole the defence load had for some time now been a stable element in the output of the industry, while its total output had steadily risen. Defence orders should, therefore, be easier to carry now without hindrance to exertions in other directions. Developments essential to the export trade and to the basic industries and services must not be held back. However, in order to ease the demand for steel and skilled men and to combat inflation it might be necessary to slow down certain investments which were not essential.

Aswan High Dam

It was announced in Washington last week-end that an Anglo-American offer of an initial grant of $70 million (£25 million) had been made to Egypt, as a supplement to World Bank financing, to help in defraying the foreign exchange cost of the first stage of work on the Aswan High Dam. Of this amount the American Government would contribute $56 million and Britain would furnish $14 million from Egypt's holdings of blocked sterling. In addition assurances were given of assistance in subsequent stages of construction. According to *The Times*' correspondent, World Bank officials estimate the cost of the project at nearly $1,300 million over the 15 years proposed for its completion and Egypt is generally supposed to be seeking $600 million of this sum from foreign sources. The Russian Ambassador in Cairo is reported to have stated that Russia is still interested in helping Egypt to build the dam and intends to take part in its construction unless specifically excluded by Egypt's agreement with the West.

PARLIAMENTARY REPORT

CRITICISMS of the policy of British Railways towards electrification and allegations of "unjustifiable delay" in putting into effect the modernization plan were expressed in a House of Lords debate on inland transport.

Viscount Bridgeman said he had nothing but praise for the plan but it was dated December, 1954, and the person who was a passenger or a consigner of goods had seen no sign of improvement in railway services. Much might have been done behind the scenes about the modernization of signals and the arrangements for the centralization of control but very little was apparent and little had been said about what was being done.

Up to date, British Railways had ordered 130 diesel-electric, 11 diesel-hydraulic and 30 power equipments. The first two kinds had been ordered from outside industry and the 30 power equipments had been ordered to enable locomotives to be built in railway shops. The ordering of pilot models was simply delaying the whole process of re-equipment—and for no reason. It had been said that to put out these 141 new diesel engines to tender was likely to deprive railway shops of work. But the amount of B.R. locomotive building, as opposed to repairing, was only about 6 per cent of the whole. The private locomotive builders were able to build them at once because they had the plant; British Railways had to start anew. In a period of over-full employment there could be no better time to redeploy labour.

Lord Hurcomb said that when he was chairman of the British Transport Commission he had found that many improvements of seemingly undisputed technical advantage did, in practice, require a long series of tests and adjustments to meet the exacting conditions of day-to-day operation. One example was automatic train control, accepted in principle five years ago but still not brought to a point that satisfied the railwaymen and the Inspecting Officer of Railways. So he would not dismiss the cautious approach as obstruction. Five or six years ago it was decided to standardize a 24½ ton mineral wagon as being the largest load which could be carried on two axles. The National Coal Board, the C.E.A. and the other users were urged to adapt their tips and sidings to take the larger wagon, from which large economies could be secured, but what progress had been made?

He wanted to see more concentration on electrification. The places where this would benefit traffic were indicated years ago: the completion of electrification in south-east England; action to remedy the obsolete and appalling conditions around Glasgow; action in the industrial areas of Lancashire; the extension of the electrification to Chelmsford; and, he hoped, a real main line scheme starting from King's Cross. But, as between the intentions of five years ago and the promise in the early part of 1955, what progress had been made?

It was true that a new factor had come in. Engineers in France had discovered that they could adopt a method of taking a high voltage supply from the original source of generation and transforming and converting it on the locomotive itself. By eliminating substations and reducing the section of the wire, the capital costs of electrification could be much reduced. He was sure that the Commission were giving anxious consideration to whether this method would be practicable in this country, in spite of our dense traffic, our numerous tunnels and the lack of clearance under bridges and so forth. Was there a risk that the process of electrification, which could go on rapidly on presently accepted methods, would be put off for a period of years if the new method were adopted?

Power for Electric Railways

Much of the plant in the Lots Road power station was non-standard and some of it must be verging on obsolescence. Was it the intention that London Transport should meet the cost of re-equipping that station and of continuing to generate its own power, or was it intended that the provision of power should be regarded as the duty of the national grid, London Transport buying power as it needed it? He was aware that there were strong arguments why London Transport should generate its own supply; but it was a big issue, involving many millions of capital. A decision could not long be deferred.

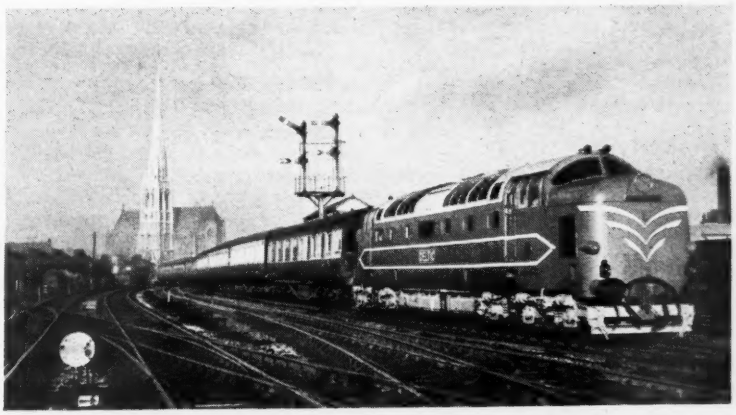
In suggesting the advantages of electrification he was not criticizing the introduction of diesels, particularly on lines with light traffic. But he could not see why prolonged periods of tests should be necessary to find a suitable diesel for main line use, nor had the House been told much about the economic justification for wholesale "dieselization" of the main lines under actual operating conditions.

Lord Glyn asked the House to realize that, although much money was being spent on dieselization, long before the last diesel was delivered power from nuclear stations would be available. In 1962 probably four stations would be in operation. Seven years was not a long time in which to place orders for the new rolling stock which would be necessary for the intensified electrification which would be possible as power from nuclear stations became available.

Lord Selkirk, Paymaster General, who replied for the Government, would not agree that there had been unjustifiable delay in implementing the modernization plan. He thought it fair to say that progress had not been unsatisfactory. Peers who wanted quick developments would be the first to complain if the Commission took a quick decision and made a mistake which it subsequently had to regret. Very big decisions had to be made and early next year a forecast of work to be carried out in 1956 and 1957 would be published. It was still hoped that the whole programme would be put through in 15 years.

Concerning the introduction of more 24½ ton wagons, the railways were held up by the limits of existing facilities for unloading at the terminals of the N.C.B. and other big users. Brakes would be put on all wagons in future but no decision had been made about the precise nature of the brake.

Here Lord Hurcomb interrupted to



The "Deltic" diesel-electric locomotive of the English Electric Co., Ltd., which was described in our issue of 21st October, made its first long-distance run on Tuesday last week. The locomotive hauled the Merseyside Express from Liverpool to London and on some parts of the route reached speeds of between 80 and 90 m.p.h.

say that the plan stated that the vacuum type had been adopted and gave an estimate of the cost. It was one part of the plan that was definite.

Lord Selkirk said the decision on this matter would be made in the very near future. Orders for 140 out of 170 of the diesel locomotives had gone to outside contractors. This was no indication of the Commission's final decision, but it showed that it was willing to consider the capacity of outside interests and was fully aware of the special knowledge of the private contractor. The Commission would submit its future electrification policy to the Minister in the near future.

Locomotive Building

In the House of Commons last week Mr. David Jones asked the Minister of Transport and Civil Aviation if, in the national interest, in view of the threat of dislocation in railway workshops caused by the decision of the British Transport Commission to order the locomotives required for the modernization programme from outside firms, he would give a general direction to the Commission that railway workshops should always be used to capacity for work which they were capable of doing.

Mr. Boyd-Carpenter said that he would not give such a direction. The British Transport Commission made it clear in its announcement on 22nd November that the present orders for diesel locomotives referred to pilot models for trial purposes and these orders should not be taken as an indication of permanent policy. Such a policy would be discussed with the unions concerned through the joint consultative machinery.

Interference Suppression

Mr. Gammans outlined the existing regulations under the Wireless Telegraphy Act applying to new cars, refrigerators and other appliances. He said that there were other sources of interference but they usually found that when the trouble was pointed out to him the offender agreed to have his apparatus put right. They were, however, considering the need for further regulations to deal with non-co-operative offenders in these other types of interference.

Gold Coast Railways

Mr. Lennox-Boyd, Colonial Secretary, informed Mr. Hector Hughes that new railway lines were being built in the Gold Coast. A new link line of 51 miles, which would reduce the distance by rail between Takoradi and Accra by 165 miles, would be completed early next year. Twelve diesel-electric locomotives and considerable quantities of rolling stock had been delivered.

Engineering Students

Mr. Malcolm MacPherson asked the Chancellor of the Exchequer how many vacant places there were this session in the engineering faculties of the universities.

Mr. R. A. Butler said that there was no fixed number of places in university departments. In the autumn term of this year there were 7,436 full-time students in university departments of engineering, an increase of 698, or just over 10 per cent, on the corresponding figure for 1954. There were, however, some departments in which more students could be accommodated if qualified applicants were forthcoming.

Clean Air Bill

Many amendments to the Clean Air Bill, which will be considered by the House of Commons in committee in the New Year, have now been tabled, a number having the backing of the Smoke Abatement Society and local authorities. Mr. Gerald Nabarro, who has tabled 70 of the amendments, proposes in one of them to increase the fine for the emission of dark smoke by a private house occupier from £10 to £100 for the second offence, and in another to increase the fine for similar emission from an industrial chimney from £100 to £1,000. Another amendment seeks to ensure that industrial boilermen should have certificates of proficiency.

Overseas Appointments

Mr. A. B. C. Harrison asked the Secretary of State for the Colonies whether he would alter the conditions of appointment in the United Kingdom Overseas Civil Service so that corporate members of the Institution of Engineers, Australia, were eligible for permanent appointment.

Mr. Lennox-Boyd replied that the qualification required for the Engineering Branch of the Overseas Civil Service was a university degree or a diploma recognized as exempting from the examinations of the Institutions of Civil, Mechanical and Electrical Engineers, plus some practical experience. Corporate members of the Institution of Engineers, Australia, were therefore eligible for entry provided they had an engineering degree of an Australian State university or the diploma of the Royal Melbourne Technical College.

Synthetic Rubber Imports

In a statement about the Government decision to license the import of synthetic rubber from the United States of America, Mr. Low, Minister of State, Board of Trade, said that so far as the balance of payments permitted the Government's policy was to allow manufacturers a free choice of materials. Synthetic rubber had technical advantages over natural rubber for certain uses; at present it was also considerably cheaper. It was important that the United Kingdom rubber industry, which made a big contribution to exports, should not be at a disadvantage, either technically or on price grounds, with competitors on the Continent, who had in the past been allowed readier access to dollar supplies than United Kingdom manufacturers, or with those in North America where there was complete freedom of competition between natural and synthetic rubber.

The Government had accordingly decided to authorize the import in 1956 of 70,000 tons of synthetic rubber of which 50,000 tons was in the form of GR-S, the main general purpose type which was competitive with natural rubber. This amount represented the estimated requirements of United Kingdom manufacturers for 1956. He was naturally aware of the importance of rubber to the Malayan economy and to the sterling area's balance of payments. But United Kingdom consumption of rubber in relation to total world production was comparatively small. Even if the Government felt justified (which for the reasons he had explained above, it did not) in denying United Kingdom manufacturers any access to supplies of synthetic rubber it would have at most a marginal effect on the market for natural rubber which reflected the supply and demand position in the world as a whole.

Overseas Trade Fairs

Mr. Arthur Palmer asked the President of the Board of Trade what steps he was taking to bring about an improvement in the quality and standards of exhibits and pavilions at overseas trade fairs in order to represent adequately Britain's industrial enterprise.

Mr. Low, Minister of State, Board of Trade, said he had no doubt that British firms exhibiting in overseas trade fairs gave careful attention to these matters, since their object in displaying their goods was to sell them. The Board of Trade and the overseas officers of the Government gave all the help they could to British exhibitors.

Ferranti Computer in Rome

The President of the Italian Republic, Signor Giovanni Gronchi, inaugurated the Ferranti electronic digital computer in the Institute of Applied Mathematics at Rome on 15th December in the presence of several hundred eminent scientists and Government officials and visitors. The speakers included Professor Colonneti, president of the National Council for Research, and Professor Picone, the eminent mathematician and director of the Institute.

Sir Vincent de Ferranti described how the invention of Professor Williams, of Manchester University, had led to the design of large-scale electronic computers. He said that the encouragement and aid of the Department of Scientific and Industrial Research and the National Research Development Corporation in Britain had led his firm to manufacture a number of computers which were now making a contribution to research, not only in Italy, but throughout the world.

Britain's Energy Prospects

RELATIONSHIP BETWEEN FUEL CONSUMPTION AND ECONOMIC ACTIVITY

THE 1955 Viscount Nuffield Paper was presented on 15th December by Dr. G. H. Daniel (Ministry of Fuel and Power) before the Institution of Production Engineers. In this the author discussed the factors entailed in securing enough primary fuel to meet a growth in demand for energy that would be a precondition of doubling the standard of living in 25 years. This would require an increase in productivity per head of 2·8 per cent per annum compound. A close relationship existed between growth in fuel consumption and economic activity, which had been in the ratio of 0·75 to 1·0 per cent since 1945, but 0·7 for fuel might be more likely in the future.

Improvement in fuel efficiency was vital and the most striking economies had been in electricity generation, but the same pace of advance could not be expected as when public supplies were replacing private generation. Moreover, a higher proportion of electricity was going into domestic and commercial premises and industrial applications where the savings were less. The growth of the fuel and power industries was not a mere consequence of the growth of other industries but was itself a dynamic promoter of general activity. For example, nuclear activities at Harwell, almost incidentally, led to new inventions, industrial processes and material worth developing in their own right.

The application of automatic control depended essentially on availability of sufficient power supplies to speed up production made possible by freeing designers from limitations of human reaction times, releasing labour for other productive work and economizing in materials and floor space. It would also reduce fuel consumption per unit of output, though it would be restricted to a small sector of the total industrial field. Assuming the fuel-income increase relationship became 0·7 to 1·0, the coal consumption in 1985 would be equivalent to 458 million tons. In most of the important industrial applications a ton of fuel oil would do the work of up to 3 tons of coal, allowing for the greater flexibility of oil as well as its higher calorific value which was expressed as 1·7/1. The price of oil had tended to fall in relation to that of coal.

The expansion of electricity consumption was inseparable from technical progress in other ways, such as electronics and ultrasonics and the acquisition by the public of domestic articles and services as a consequence of rising incomes. Its competitive position had been strengthened by the fall in its price relative to other prices and wages. At the beginning of the century for the price of an hour of unskilled labour one could buy 2 kWh, compared with 30 kWh to-day. Estimates of demands at five-yearly intervals for primary fuels by different classes of consumers were as given in Table 1 and for electricity in Table 2.

To the safely high estimate of 458 million tons in 1985 might be added coal for bunkers and an arbitrary figure of 10 million tons for export, making an overall total of 479 million tons. In that year the equivalent of 94 million tons of coal could be expected to come from nuclear power, 155 million tons from oil and 5 million tons from expansion of hydro-electric capacity (1,700 kWh=1 ton of coal). The demand to be met by coal would then be about 225 million tons, which would be less than the National Coal Board target of 240-250 tons per consumer. Large investments in coal mining over the next 30 years would nevertheless still be necessary to produce that amount of coal at a reasonable price.

TABLE 1.—DEMAND FOR PRIMARY FUEL IN PRINCIPAL CONSUMING SECTORS

	Million tons of coal equivalent						
	1954	1960	1965	1970	1975	1980	1985
Agriculture ...	2·8	3	4	5	6	6	7
Iron & Steel ...	32·5	39	44	49	54	59	64
Manufacturing	67·6	82	95	108	122	136	152
Collieries ...	11·4	10	8	8	7	7	7
Refineries ...	3·3	4	5	6	7	7	7
Total industry	117·6	138	156	176	196	215	237
Railways ...	15·0	13½	11½	9	8	7½	7
Other transport	17·3	21	23½	26	28	29½	31
Domestic ...	65·3	69	73	78	83	88	94
Miscellaneous...	29·4	34	38	43	48	54	60
Total inland	244·6	275½	302	332	363	394	429
Foreign bunkers	9·0	9	9½	9½	10	10	10½
Total ...	253·6	283½	311	341½	373	404	439½

Notes: (1) The consuming sectors are the sectors of final consumption, the electricity, coke and gas used in these sectors being expressed in terms of the primary fuel needed to produce them. (2) One ton of oil products is assumed to be equal to 1·7 tons of coal. One ton of gas coke = one ton of coal and one ton of metallurgical coke = 1·3 tons of coal. Electricity is expressed in tons of coal on the basis that a ton of coal yielded 1,650 kWh in 1954 and that the yield will increase to 2,300 kWh in 30 years' time.

TABLE 2.—ELECTRICITY REQUIRED

	Domestic	Industrial, including agriculture	Other	Total	Electricity sent out (1,000 million kWh)	Million tons of coal equivalent	Required capacity of power stations (million kWh)
1954	18	32	13	63	70	42	20½
1960	26	49	19	94	105	56	29
1965	33	68	27	128	142	71	38
1970	40	90	34	164	181	86	47
1975	50	114	45	209	231	104	58
1980	62	139	57	258	284	123	70
1985	74	165	69	308	339	145	82

Lighting and Architecture

IN a paper presented on 13th December before a joint meeting of the Royal Institute of British Architects and the Illuminating Engineering Society, Mr. Derek Phillips dealt with the need for co-operation in the two fields. The R.I.B.A. examinations, he said, virtually ignored lighting; consequently architectural students might reach the end of their training with little or no knowledge of either natural or artificial lighting. Students of illuminating engineering could gain full marks in the City and Guilds examinations without knowledge of the buildings for which they would plan installations.

The three aspects of design of lighting were man, light and architecture from the æsthetic and the scientific and technical points of view, but the only common meeting ground was in the placing of lighting equipment, and there was no common vocabulary of design. Training in the two professions should be modified to bridge the gaps, the integrating criteria of design being constantly under review. The architect should consider the lighting of his building initially and the illuminating engineer should co-operate with him on the more complicated problems. The latter might be an electrical consultant or a specialist member of an architectural partnership, both without any commercial attachment. The manufacturer would then be primarily concerned with the development of equipment to meet the pattern set by architects and consultants.

INDUSTRIAL NEWS

Power Convention Exhibition

The British Electrical Development Association has again been invited by the Council of the British Electrical Power Convention to arrange an exhibition at Torquay, from 23rd to 29th May, 1956. The exhibition will be held in a marquee, erected on Torre Abbey Meadows, an ideal site on the main promenade between the Belgrave and Grand Hotels.

As in former years a limited amount of space will be available for electrical manufacturers who are not identified with any of the organizations participating in the Power Convention. Early application should be made to the director and secretary, British Electrical Development Association, 2, Savoy Hill, W.C.2.

New B.B.C. Building

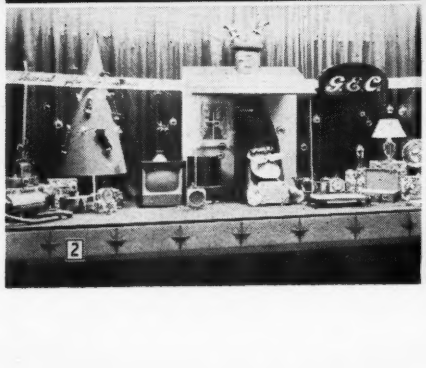
The British Broadcasting Corporation has let the vacant site adjoining Broadcasting House, Portland Place, W.1, to the Prudential Assurance Co., Ltd., which has agreed to construct an office building which will have a different architectural style, but will be in sympathy with Broadcasting House. The architect is Mr. H. Fitzroy Robinson, B.A. (Arch.), F.R.I.B.A., with Sir Howard Robertson, A.R.A., P.P.R.I.B.A., S.A.D.G., as consultant, and the design has recently been passed by the Royal Fine Art Commission. It is hoped that construction will be started next autumn. On completion the B.B.C. will take a lease for a long term and will occupy the whole building primarily as administration offices. In part of the basement the B.B.C. will construct two drama suites, four talks studios and related recording rooms, and two discussion studios, all for sound broadcasting; on the ground and first floors, areas will be left for completion by the Corporation of a new main control-room and accommodation for other technical facilities.

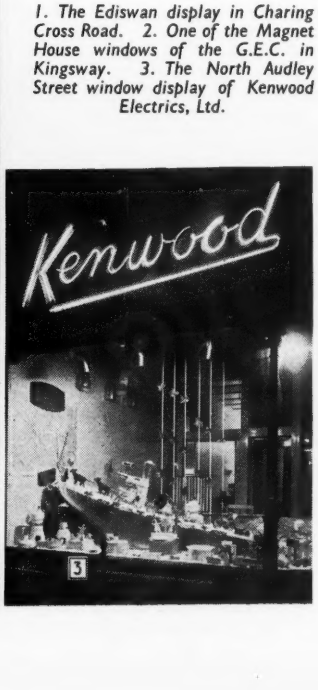
Transmitters at Wenvoe

To provide interference-free reception of the Home, Light and Third programmes over a considerable part of the B.B.C.'s Welsh and West Regions, the first of six 10 kW frequency-modulated transmitters will shortly undergo operational trials at Wenvoe. Designed and manufactured for the B.B.C. by Standard Telephones & Cables, Ltd., these transmitters incorporate the latest techniques in very high frequency broadcasting. In order to ensure uninterrupted service these transmitters will work in parallel, one pair for each programme. In addition a special combining network has been designed by S.T.C. engineers in co-operation with the B.B.C. to permit the operation of three transmitters carrying different programmes into a single antenna.

Christmas Window Displays

Electrical domestic appliances and fittings will have solved many problems this Christmas for those seeking useful and novel presents, and the various electrical concerns throughout the country have endeavoured, by attractive window displays, to help Christmas shoppers in making their choice. In the accompanying pictures we show three examples of well-planned London displays by the Edison Swan Electric Co., Ltd., the General Electric Co., Ltd., and Kenwood Electrics, Ltd.





1. The Ediswan display in Charing Cross Road. 2. One of the Magnet House windows of the G.E.C. in Kingsway. 3. The North Audley Street window display of Kenwood Electrics, Ltd.

Trade with the Philippines

An article on this subject in the *Board of Trade Journal* states that the Philippine Republic is anxious to increase its trade with European and sterling area countries. A table shows that United Kingdom exports to the Philippines have steadily risen during the past three or four years. So far as electrical machinery and equipment is concerned the total values have been as follows:—1952, £38,000; 1953, £28,000; 1954, £54,000; and January-September, 1955, £94,000.

Municipal College Rewiring

Burnley General Purposes Committee has rejected a proposal that the Corporation Works Department should carry out electrical rewiring work at the Municipal College at a cost of £12,833 and has recommended that the lowest tender received should be accepted. Five tenders had been received for the work, the lowest amounting to £9,914, to which had to be added 2½ per cent (this being the North Western Electricity Board's fee for the preparation of the specification), 2 per cent (for staff salaries) and 2½ per cent for builders' work.

Charles Colston Acquisitions

The assets of two light engineering works have been acquired by Charles Colston, Ltd. The companies are Tallent (Aycliffe), Ltd., Co. Durham, and Smith-Richards, Ltd., High Wycombe, Bucks. A programme of expansion is in hand at both factories to cater for a large development scheme, for which capital of several million pounds will be available if required. Mr. J. P. Ford, managing director of Charles Colston, Ltd., has been appointed chairman of these two subsidiaries.

Prices and Wages

The December *London and Cambridge Bulletin* gives data on prices, wage rates and earnings from 1948 to 1955. The retail price index moved from 175 in 1948 (average) to 247 in October, 1955, an increase of 41·14 per cent; the index of weekly wage rates rose from 177 to 257, an increase of 45·19 per cent; and the rise in the index of average weekly earnings was from 138 in 1948 to 217 in April, 1955, an increase of 57·24 per cent. While prices and wage rates have almost kept in step, earnings were in excess of prices by 16·1 per cent and of wage rates by 12·05 per cent. Higher

average earnings were mainly accounted for by the longer hours worked—49 per week in April, 1955, as against 46·5 in April, 1948.

Next Week's Events

Members of most of the institutions and societies will be engrossed in fulfilling duties other than those of a professional nature next week. I.E.E. members with families may wish to be reminded, however, of the annual schoolchildren's lecture which will be given at the Institution on Thursday and Friday next (3 p.m.). This year's lecturer is Mr. R. Brooks, B.Sc., M.I.E.E., whose subject will be "Electric Traction." The opening of the National Boat Show (on Thursday), at Olympia, should appeal to young and old alike. The exhibition will continue until 10th January. In Glasgow, the Scottish Section of the Institute of Marine Engineers is holding a meeting at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent (29th December, 7.30 p.m.), at which Mr. K. Maddocks will read a paper on "Nuclear Power for Commercial Vessels."

B.E.A.M.A. Essay Competition

We are reminded by the British Electrical and Allied Manufacturers' Association that the closing date for entries in their essay competition, "The Future and the Trolleybus," details of which were given in our issue of 30th September, is 31st December. Entries should be addressed to the secretary, Electric Traction Section, B.E.A.M.A., 36, Kingsway, London, W.C.2.

Lamps from Japan

The Board of Trade Licensing Department has issued Notice to Importers No. 688 which deals with interim arrangements for the importation of certain goods from Japan. Quotas have been established for the twelve months ending 30th September next and licences valid until that date will be issued within the total amounts shown in a schedule to the Notice. Among the items included are electric filament lamps, 12 V or less, for which the amount of the first instalment is £7,500 (c.i.f.); filament or discharge lamps (including fluorescent) for over 12 V, £5,000; and cycle, pocket and hand lamps, etc., and lighting appliances and fittings, £12,500.

Cathedral Floodlighting

Few Christmas lighting schemes fit the occasion better than the floodlighting of Lincoln's incomparable hilltop cathedral. It is being illuminated for the third successive year from 6 p.m. until midnight from 23rd December. The equipment was originally used for the Coronation and is the property of Lincoln Corporation, the installation being undertaken by the East Midlands Electricity Board Contracting Department. The 61 floodlights used have a total loading of 58·3 kW, making the cathedral with its 272ft high centre tower visible for miles around. At close quarters the detail of the architecture, in particular the 12th century west front, with its deep internally graded recesses before the entrances, is effectively emphasized. To cover the west front, the dimensions of which are 125ft high by 130ft wide, five 1,500 W wide-angle and seven 1,000 W medium-angle floodlights are used.

Christmas illuminations at King's Road, St. Leonards and (right) the impressive floodlighting of Lincoln Cathedral

Lighting for Christmas Shows

Christmas pantomimes are nowadays less seen in the theatre, but pantomimes on ice are increasing in popularity, where increased space lends itself to spectacular and exciting effects. Lighting has played a big part in the transition, particularly for the presentation of complete scenes in ultra-violet light. This year, Atlas u.v. tubes, made by Thorn Electrical Industries, Ltd., are being used in the "Sleeping Beauty" at Shrewsbury, "Aladdin" at Murrayfield, Edinburgh, "Humpty Dumpty" at the Kings Theatre, Southsea, and "Dick Whittington" at the Sports Stadium, Brighton. In addition to these ice shows the Harringay Circus and Wild West Show have special u.v. sequences.

New Cable & Wireless Building

On Tuesday last week Mercury House in Theobald's Road, London, W.C.1, the new building of Cable & Wireless, Ltd., was officially opened by Lord Reith, chairman of the Colonial Development Fund. In 1950 the Post Office took over the company's United Kingdom assets and the services it operated here including the London Telegraph Station. This station had long been growing in importance and size and it soon became clear that if room was to be found for continued expansion in Electra House the company's head office would have to find accommodation elsewhere. As a result the present building has been erected with office accommodation for some 770 people and as the company's head office staff numbers only 450 the first floor and parts of the ground floor have been leased to the Telegraph Construction & Maintenance Co., Ltd., for its head office, previously at 22, Old Broad Street.

Window Dressing Competition

L. G. Hawkins & Co., Ltd., announce that the first three prize-winners in the window dressing competition held in conjunction with its sales carnival were:—First (£100): H. T. Burgess & Son, 20, Windmill Street, Gravesend; second (£50): Super Radio Co. (Bradford), Ltd., Bank Street, Bradford; third (£25): Moore & Bush (Electrical), Ltd., The Parade, Trowbridge, Wilts. Altogether twenty-three prizes were awarded.

Trans-Antarctic Expedition

For the Trans-Antarctic Expedition, the advance party of which left Britain in the M.V. *Theron* recently, Crompton Parkinson, Ltd., supplied two hermetically sealed, 4in diameter dial, circular scale instruments. These instruments, a synchroscope for the phasing of two 6 kW 50 c/s single-phase generators and a frequency meter, will form part of the generating equipment supplied by Auto Diesels, Ltd., to be installed at the expedition's base on the shores of the Weddell Sea. Both were specially designed to withstand the exacting sub-zero conditions and incorporate many special features which will enable them to retain a high degree of accuracy within a temperature range of −40 deg C up to 70 deg C.

Films for Industry

A new edition of "Films for Industry" (139 pp., price 2s) has been published by the Central Office of Information, 83, Baker Street, London, W.1. It contains brief particulars of about 500 films obtainable

on free loan from the Central Film Libraries in London, Glasgow and Cardiff as well as particulars of 57 film strips (costing 7s 6d each) and of 111 "recommended" films available from other sources. Among the subjects in the classified arrangement of titles are the electrical industry, electronics, telecommunications and engineering.

Holidays-with-Pay Scheme

From the week beginning 2nd January the value of the weekly credit stamps under the holidays-with-pay scheme operated in the electrical contracting industry is to be raised from 6s 6d to 7s 3d in respect of all journeymen and from 5s 6d to 6s in the case of adult mates.

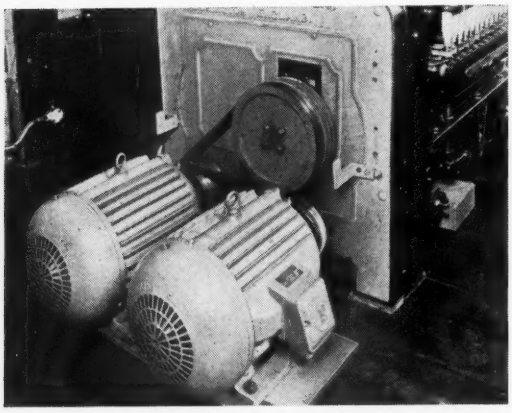
Textile Spinning Frame Drive

A simple system for driving textile ring spinning frames using two identical electric motors has been evolved by the English Electric Co., Ltd. Known as the "two-speed drive" system, it has been installed with advantage on ring frames spinning up to 90's counts, and can be fitted to all makes of new and existing ring spinning frames.

The ring spinning frame was designed not only to give a higher yarn production but also a continuous spin. Its main disadvantage is that, when driven at a constant speed, the yarn tension varies throughout the spinning period. This tension depends upon the diameter of the yarn package, or cop, on the spindle at the point at which it is wound on, and also varies cyclically with the ring rail position. This variable tension creates thin places along the length of the yarn which is known as "yarn irregularity." The tension is greatest when being wound on to the smallest diameter of the conical build of the cop, and is least when approaching the maximum cop diameter. An interesting feature is that the end-breakage rate is greater at the bottom of the package at commencement of spin, and also at the nose or end of spin, than it is for the central body of the cop.

The new drive is designed to reduce these end breakages and to increase the production and quality of the yarn itself. Two identical squirrel-cage induction motors are connected together by V-belts and pulleys, one pulley being slightly larger in diameter than the other. A drive is taken from the smaller pulley to the roller shaft of the ring spinning frame. When the motor with the smaller pulley is energized, the frame runs at a lower speed than when the motor with the larger pulley is energized and thus two driving speeds are available. The actual changes of speed are arranged to take place when the bottom of the cop has been built and at the nose of the cop, the speed changes being from "low" to "high" and then to "low." These speed changes are effected by a cam-operated switch attached by a flexible shaft to the ratchet wheel shaft of the builder motion of the frame.

The switch is arranged to operate either of two main contactors electrically, the contactors being mechanically interlocked so that both cannot be "in" together. For frames fitted with an electromechanical brake to prevent snarls in the yarn when coming to a standstill, a third contactor is provided, which operates before either motor is energized.



English Electric two-speed drive for a ring-spinning frame, with guard removed to show the pulleys and V-belts. The motors are each rated at 10 h.p., 1,455 r.p.m.

New Year Holidays

The works of Bruce Peebles & Co., Ltd., Edinburgh, will be closed for the New Year holiday from 30th December to 5th January.

Calendars and Diaries

The neat pocket diary received from Nettle Accessories, Ltd., contains much useful technical data and includes illustrations of various forms of interference with television reception. The diary is bound in dark green leatherette.

Wild-Barfield, Ltd., has sent us a heat-treaters' pocket diary in blue leatherette which contains 102 pages of technical data.

The calendar of the Edison Swan Electric Co., Ltd., has monthly sheets, each of which bears a picture in colour of well-known landmarks.

Monthly sheets with bold figures form the calendar received from G. S. Peckham & Co., Ltd.

The River Wye at Bakewell, Derbyshire, makes an attractive picture for the calendar, with monthly slips, received from the D.P. Battery Co., Ltd.

The tasteful calendar received from Stewarts & Lloyds, Ltd., has monthly cards, and it can be either hung on the wall or used as a desk calendar.

A colourful picture of huntsmen forms the calendar of Kent Bros. Electric Wire Co. & E. H. Phillips, Ltd., which has monthly slips.

The AC-Delco Division of General Motors, Ltd., has sent us an engagement calendar with monthly sheets, advertising the company's products.

A pocket diary has been received from W. & E. Kupfer, Ltd., which is nicely bound in navy blue limp leather.

The calendar received from the Lindley Thompson Transformer & Service Co., Ltd., bears a well-executed picture of a red squirrel. The monthly slips also show the preceding and following months.

A useful engagement calendar has been received from Laurence, Scott & Electromotors, Ltd., which includes photographs of well-known beauty spots.

"Our Heritage" is again the title of C. A. Parsons & Co.'s calendar and again there are large monthly sheets bearing reproductions in colour of historical and beautiful places in England, Scotland and Wales.

Washing Machine Prices

We are asked by the British Vacuum Cleaner & Engineering Co., Ltd., to say that the prices of the "Goblin" W140 electric washing machine shown in their advertisement in our 16th December issue (p. 28) should have been £58 10s plus £27 7s 7d purchase tax with heater, and £52 10s plus £24 11s 5d purchase tax without heater.

Trade Announcements

On 14th December **J. H. Fenner & Co., Ltd.**, of Hull, opened a new branch for mechanical power transmission equipment in Leicester. The new premises are situated in a central position at 50, Southgate Street, where for two days an exhibition of the complete range of the company's products, including the torque-arm shaft mounted speed reducer, was held. Visitors were received by Mr. S. Parker, regional manager, Mr. W. K. Porter, Nottingham branch manager, and Mr. R. H. H. Dyer (Leicester area).

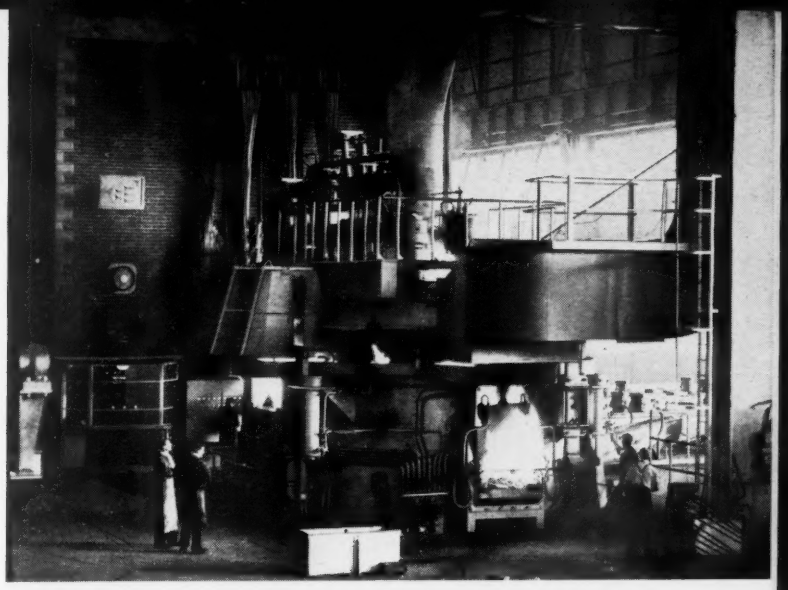
The dynamic balancing machine previously marketed by **Dawe Instruments, Ltd.**, and described in our issue of 8th July last, is now being sold by **Small Electric Motors, Ltd.**, Eagle Works, Churchfields Road, Beckenham, Kent, who hold the patent rights and are the manufacturers. Dawe Instruments, Ltd., is augmenting its own range of balancing machines by the production of a large console model which will be shown at next year's Physical Society Exhibition.

Taymen, Ltd., inform us that owing to the heavy demand for their hydraulically driven pole hole boring machine they have handed over the manufacture and world selling rights to **Steel Fabricators (Cardiff), Ltd.**

Modern Steelmaking

Use of the Electric-Arc Furnace

By R. WILCOCK, A.Met., F.I.M.*



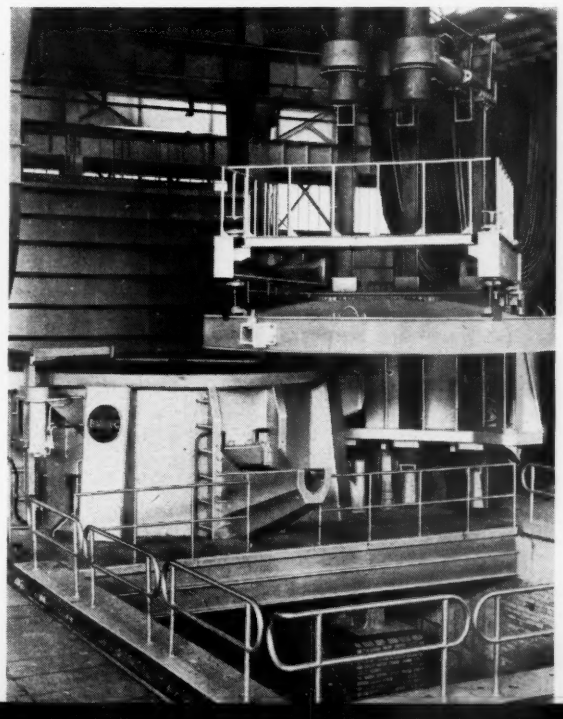
General view of 60 ton furnace in operation

THE Battelle Report on "Comparative Economics of Open-Hearth and Electric Furnaces for Production of Low-Carbon Steel" published in 1953 has not caused quite so much interest among steelmakers in this country as might have been expected from a document which draws such far-reaching conclusions. This report, sponsored by a group of electric utility companies and the Bituminous Coal Research, Inc., in America, has been carried out by the staff of the Battelle Memorial Institute and can be regarded as thoroughly unbiased. It is based on an extremely thorough sifting, correlation and expert appraisal of a huge amount of information taken from many sources —operating companies, equipment manufacturers, utility companies, and many independent experts in various fields.

The findings are, broadly, that in the production of low-carbon (or tonnage) steels, an economic advantage can be shown for the large electric-arc furnace compared with the gas- or oil-fired basic open-hearth furnace when using cold-metal practice. In this practice the steel scrap and pig iron, making up the furnace burden, is charged cold, contrasting with the so-called integrated works which take a high proportion of pig iron still molten from the blast furnaces—known as hot-metal practice.

* Samuel Fox & Co., Ltd.

General view of the 60 ton arc furnace of Samuel Fox & Co., showing the mechanism for lifting and swinging aside the roof



This is, perhaps, a surprising conclusion in that electric power for steel melting is considerably dearer than the competitive fuels, producer gas, coke-oven gas, and, in more recent years, the heavy residual fuel oils which are increasingly replacing those fuels based on coal.

The report shows in considerable detail how the higher fuel costs can be offset, and even outweighed, by other factors; to take one example from the wealth of tables in the report, under American conditions an open-hearth plant to produce 500,000 short tons of ingots per annum would have a capital cost of $16,900,000, compared with a figure of $10,500,000 for the corresponding arc furnace plant. The difference is accounted for not only by the furnaces themselves but also by the extra cost of buildings and ancillary equipment necessary for the open-hearth plant.

In operating the cold-metal practice, the arc furnace shows itself to advantage in a much reduced melting-down period, so reducing overheads that the higher fuel costs are more or less offset. By using a high proportion of steel scrap and little, if any, of the relatively expensive pig iron, and by achieving a higher yield of saleable steel, the arc furnace thus shows a lower total cost than the open-hearth.

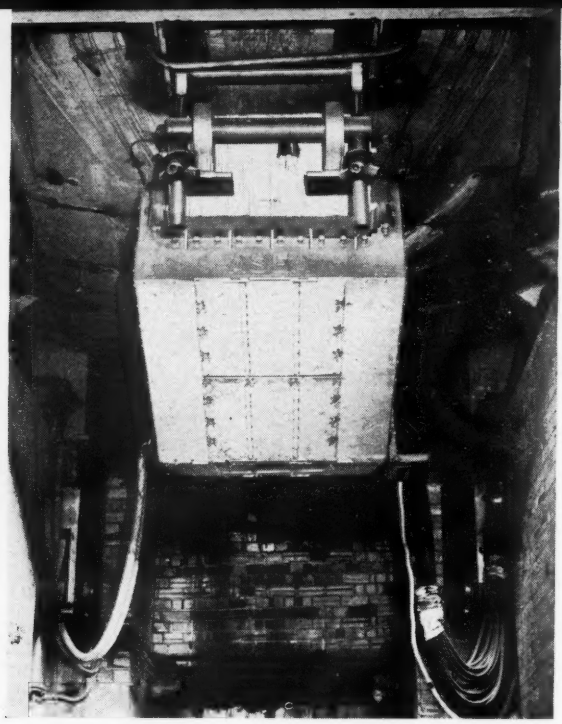
With hot-metal practice the position is different. The time saving is lost when a large part of the burden is already molten when charged, and fuel costs are, therefore, appreciably higher for the electric furnace; this, together with the fact that the raw materials are essentially the same for both types of furnace, means that the open-hearth furnace under these conditions is easily cheaper.

The writer does not intend to consider any further, in this article, the estimated economics in so far as they can be translated to conditions in this country, as that has been dealt with in previous articles by Robiette[1] and Howard[2], but rather will discuss the implications of the report as they appear to the steelworks concerned with operating both arc and open-hearth furnaces. But whereas the report is concerned entirely with low-carbon ordinary grades of steel, the writer feels that the major developments in electric melting in this country will, in the immediate future, be more evident in works producing alloy and special steels, and will, in addition, consider this aspect.

Present Position

Two major factors can, perhaps, help to explain the British attitude; firstly, arc furnaces in this country are small in comparison with many in the U.S.A. Until quite

[1] A. G. Robiette, *Iron & Coal Trades Review*, 27th November, 1953.
[2] J. C. Howard, *Electrical Review*, 18th June, 1954.



View of the A.S.E.A. stirrer fixed to the bottom plate of the 60 ton furnace

recently the largest arc furnaces here were of 30 tons capacity and even now there is only one larger furnace in operation, nominally of 60 tons, but actually tapping 70 tons. More usually, however, furnaces are of the order of 10 tons capacity. Secondly, arc furnaces have been used almost (though not quite) exclusively for the production of special grades of steel; alloy steels, stainless steels, and the higher carbon qualities. These " electric quality " steels are produced by a special steelmaking technique, the double-slag process, in which the first, or oxidizing, slag is removed, and a second " reducing " or refining slag is substituted in order to de-oxidize the steel and, in particular, to reduce the sulphur to a very low value. This technique takes time and, therefore, is costly but produces a steel of highest quality which, of necessity, commands a price premium over steels produced in open-hearth furnaces.

As will be realized from the above, existing arc furnaces in Britain are almost entirely installed in works specializing in high-grade steels. Because of their size they cannot be worked economically on the low-carbon " tonnage " steels suggested in the report and even if they could, from the steelmaking angle, they are associated with rolling mills specializing in short runs and using small ingots, which cannot afford to deal with the commoner grades of steel.

In my own company, as in many others, small arc furnaces have produced, from time to time, short runs of steel to open-hearth as opposed to arc furnace standards, but these have been in alloy steels where other factors are involved. Even so, they have not been able, because of their small size, to compete with open-hearth furnaces of, say, 80 tons capacity.

The pattern of development of electric melting furnaces in Britain has, therefore, been that they have never been seriously considered as competitors of open-hearth furnaces and still less that they could be so when making the cheapest grades of steel.

Large Arc Furnaces

From the standpoint of " electric-quality " steelmaking, until quite recently, based largely on a lack of actual experience, there has been doubt among British steelmakers whether larger furnaces could maintain the high standards of quality for which arc furnaces are renowned; and if control and uniformity might not suffer as size increased. Experience in the U.S.A. tended to belie this and certainly the 60 ton furnace installed by Samuel Fox & Co., Ltd., which has been in operation since November, 1954, has given just as good quality as the 12½ ton units working alongside. It seems almost certain now that future developments in electric melting in this country will be directed to increased furnace size, probably to somewhere between 60 and 100 ton capacities. Though perhaps not entirely relevant to the general theme, a brief note on a fairly recent development is probably interesting: the electro-magnetic stirrer developed by the Swedish electrical firm of A.S.E.A. This equipment has been applied to a number of furnaces in Sweden and elsewhere, but the first unit was only installed in this country in August of this year.

The equipment consists of a large stator winding fastened below the hearth plate of the furnace which induces a moving magnetic field in the liquid metal. In order to avoid losses the hearth plate in the furnace shell has to have a panel let in of relatively expensive non-magnetic stainless steel. The movement of metal effected gives better contact between the slag and metal, so tending to speed up physical-chemical reactions and giving greater uniformity of composition within the bath of metal. There has been too little time yet to arrive at any reliable assessment of the metallurgical value of the stirrer, but another benefit (much appreciated by the furnace workers) can be confirmed from personal observations. The removal of the slag can be achieved by reversing the direction of stirring so that only very little help from the furnace hands is needed compared with the 10 or 15 min of hot and heavy work involved in " rabbling " off the slag by hand.

Electric Steelmaking Abroad

The attitude of regarding the electric-arc furnace solely as a producer of special qualities is widespread but not universal. For example, in Scandinavia the steel industry is based on superlative iron ores, admirably suited to production in acid open-hearth furnaces, and this process has become the mainstay of the famous specialized steel industry of Sweden. That country, however, having ample supplies of cheap electricity from water power, but no home resources of coal or oil, is turning more and more to electric furnaces, but confining their use almost entirely to the lower grades of steel, regarding the open-hearth furnace as producing a much superior product.

In the U.S.A., although used for quality and stainless steels, the advantages of flexibility in operation of arc furnaces in cold-metal practice have been recognized, and many furnaces are used as envisaged in this report. This has shown itself too in the greater readiness to follow their national inclinations and install large units; furnaces in the order of 100 tons capacity are quite normal.

Here, perhaps, a word of caution is needed; it must not be assumed that the U.S.A. is turning over to any great extent to electric melting at the expense of oil or gas firing in steelmaking. Most low-carbon steels in that country, as in Britain, are made in integrated plants where the advantages lie very clearly with the open hearths and most of the future large tonnage installations will almost certainly follow the existing pattern, in this country no less than in America.

Table I shows the proportions of the national steel make produced in electric furnaces for Britain and the U.S.A.

The relatively small amount of electric melting puts the picture into perspective, though the tendency for the proportion to rise more quickly in the U.S.A. than in Britain, particularly in the last decade, is evident. It should also

TABLE I.—PERCENTAGE OF STEEL PRODUCTION ELECTRICALLY MELTED

Year	U.K.	U.S.A.
	%	%
1920	1·0	1·5
1930	1·0	2·0
1940	3·4	2·5
1950	4·5	6·2
1951	5·3	6·7
1952	5·7	7·3
1953	5·3	6·5

TABLE II.—OUTPUTS FROM DIFFERENT FURNACES

Type of furnace	Capacity, tons	Transformer rating, kVA	Annual output ingot, tons
Electric arc	12½	3,500	14,500
,, ,, ...	20	6,000	25,000
,, ,, ...	60	15,000	55,000*
Basic open-hearth ...	70		41,000†

* Estimated from six months' working.
† Based on a weekly output the figure for the open-hearth would be much higher, but because of necessary repairs an open-hearth is not available for as many weeks in a year as is an arc furnace.

be noted that, expressed in tonnages rather than in percentages, the American figures are much more impressive: for 1953 the 6·5 per cent represents 6,500,000 tons of ingots compared with 930,000 tons produced in Britain.

It seems obvious that the economic justification for replacing gas- or oil-fired with electric furnaces will not be achieved by small furnaces such as make up the bulk of the electric melting equipment already in existence, but is inevitably linked with the installation of larger units such as the 18/20ft diameter furnaces suggested in the report. Some idea of the effect of furnace size can be gained from the following figures. Working the two-slag process we expect annual outputs from various types of furnaces, roughly as shown in Table II.

The productivity does not rise quite in proportion with furnace size, but it will be realized that by using mechanical aids, such as charging machines for fluxes, etc., basket charging, and the use of the electro-magnetic stirrer, little extra manning is needed for a large furnace than for a small one.

Let us now look at Table III showing the pattern of steel production in this country as it is at present and see what possibilities there are of increasing the proportion that could, with advantage, be made in large arc furnaces.

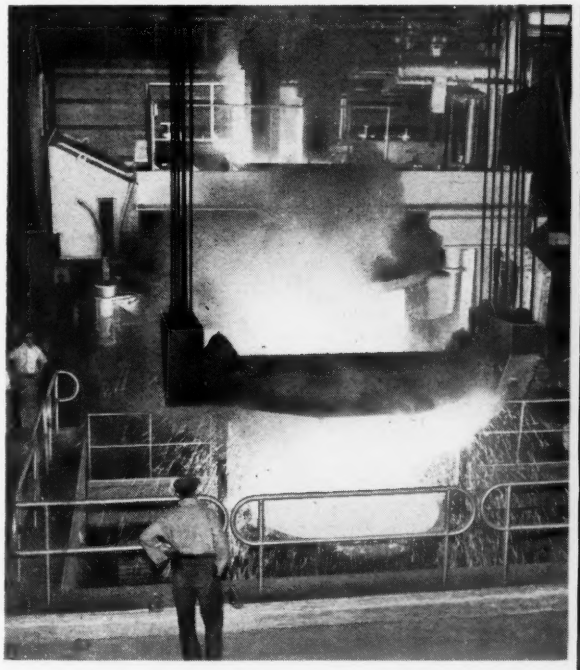
TABLE III.—PRODUCTION OF OPEN-HEARTH AND ELECTRIC STEELS IN U.K.

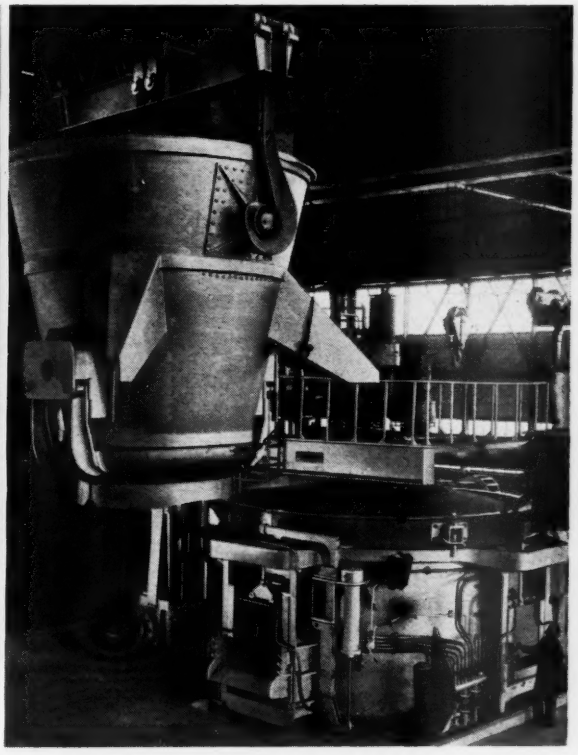
Process	1953		1954	
	Tons (000)	% of total production	Tons (000)	% of total production
Acid open-hearth ...	1,132	6·44	995	5·36
Basic open-hearth ...	14,297	81·3	15,249	82·4
Electric	929·7	5·27	929·4	5·02
Total steel production	17,608	—	18,519	—

Acid Open-Hearth Process

In this process it is not possible to remove sulphur and phosphorus. High-class raw materials are consequently mandatory; in particular a special " acid " or " hæmatite " pig iron is needed. There are no longer sufficient suitable indigenous ores for producing such pig iron and so most of the ore for this purpose has to be imported. Shortage of suitable scrap steel is another factor making it difficult to work the process. A further economic disadvantage is that the high sulphur present in fuel oils precludes their use for the acid furnace, and so producer gas has to be used, giving notably lower productivity than with the basic process.

Acid steel is less prone than steel made by basic processes to develop the fine internal cracks known as hair-lines or snowflakes, and so has particular attraction for the manufacture of castings and large forgings. For these purposes the process is very well established; but the flexibility of the arc process, when larger furnaces are more customary, will surely recommend it in spite of the disadvantages noted above which could necessitate longer heat treatment processes for the forgings.





Tapping the 60 ton arc furnace and (right) the charging bucket for the furnace

The other major use of the acid process is for alloy structural steels. Many years ago the acid furnace produced almost all these steels, but the basic open-hearth has gradually taken over many of the grades as the prejudice against the latter has died away. There remain, however, some steels which can be made only by the acid or arc furnaces. The question arising is: can the latter compete on price? At present, with small furnaces, costs favour the acid open-hearth, but with larger furnaces the difference can, at any rate, be reduced. All in all, there is little doubt that production in the acid open-hearth will decline still more in the future, to be replaced by arc furnace steel.

Basic Open-Hearth

Turning now to the basic open-hearth process, which accounts for by far the bulk of the steel produced, we might first consider the special and alloy steel trade which is only a small proportion of the whole, and where the factors are very much the same as for the acid furnaces. Even the use of a cheaper raw material (100 per cent, or nearly 100 per cent scrap) does not enable even the large arc furnaces to compete when using double-slag techniques and working to the low sulphur and phosphorus specifications usual in arc practice. However, working to open-hearth standards as regards sulphur and phosphorus would certainly vastly increase the productivity; we have not much direct information, but one heat made in the 60 ton furnace took only 4½ hours compared with the more usual time, when making to electric standards, of 7 hours. We have insufficient data to make a thorough economic assessment of this approach, but the implications are obvious.

One snag appears in this assessment: the process depends on having adequate supplies of scrap. In the Battelle Report the saving effected by using scrap mixes is the factor swinging the advantage in favour of the electric furnace for cold melting. The following extract from a table in the report for a plant to produce 500,000 tons per annum illustrates this point:—

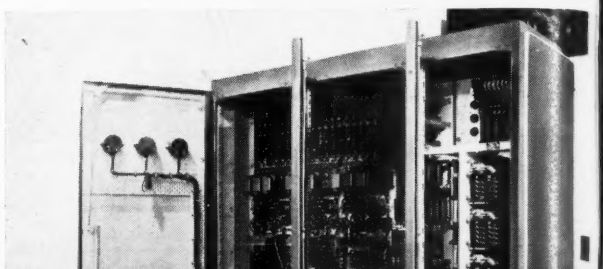
TABLE IV.—COST PER TON OF INGOTS (DOLLARS)

	Cold Charge		Hot Charge	
	Open Hearth	Electric Furnace	Open Hearth	Electric Furnace
Cost above*	16·52	17·07	13·95	15·95
Cost of metallics ...	47·80	44·10	42·23	41·33
Net production cost ...	63·17	60·02	55·03	56·13

* Cost above broadly embraces capital charges and all operating costs other than the cost of the metallic charge.

At present, scrap in this country is in short supply. This country has, in the past, been an importer of scrap on a large scale, but foreign sources are no longer so plentiful and the steel industry in general is having to use a higher proportion of pig iron than was previously the case. If sufficient scrap is not available the possibility of the arc furnace competing with the open-hearth diminishes.

If the arc furnace had to work with any appreciable quantity of pig iron in the charge, it would have to employ the single slag process. British pig iron contains about 1¼ per cent of phosphorus and low phosphorus acid iron would be prohibitively expensive. During the first stages of steelmaking this phosphorus is oxidized and goes to the slag. In normal two-slag working this phosphorus-rich slag is removed and replaced by a reducing slag which cannot hold phosphorus. The last traces of the high-phosphorus slag cannot be removed from the furnace and the phosphorus remaining is returned to the metal by the reducing slag. Normally, when using scrap mixes, the amount of phosphorus reversion is not enough to worry about. Not so with pig iron; several extra slagging-off



Amplidyne equipment for controlling the electrodes on the 60 ton arc furnace

operations would be necessary, increasing the furnace time and decreasing productivity to the extent that we consider that even as little as 20 per cent basic pig iron in the charge would make the two-slag process hopelessly uneconomic.

Single-slag working would, in any case, be necessary to compete with open-hearth steelmaking for the manufacture of low-carbon steels in order for the productivity to be high enough to offset the high electricity cost. We have not the data in this country to be certain from actual experience, but it is likely that outputs roughly 50 per cent above those when working double-slag processes could be achieved with some regularity. With adequate scrap such a plant could, no doubt, compete with an open-hearth plant as is suggested in the report.

Conclusions

The report has shown that the electric arc furnace can compete, in some circumstances, with oil- or gas-fired open-hearth furnaces when making low-carbon steels.

(1) Capital costs are lower for arc furnaces than for open-hearth plants.

(2) This, together with quicker melting, almost, but not quite, offsets the higher fuel cost of the electric process when melting cold charges.

(3) On the other hand, with hot-metal practice, the charge being mostly liquid to start, the advantage of quick melting is lost and the fuel and capital charges combined are appreciably greater for the electric furnace.

(4) Big savings in the cost of metallics in the charge are made by the electric process compared with the open-hearth in cold-metal practice, but the saving is negligible when working hot-metal practice.

(5) These factors combine to indicate that there is an economic advantage for the electric furnaces when using cold-metal practice, but a definite advantage in favour of the open hearths when working hot-metal practice.

To these conclusions, considering the conditions from the British standpoint, we must add the following:—

(6) The possibilities of the arc furnace being competitive with open-hearth demands large arc furnaces, not the relatively small ones making up the present equipment available in Britain.

(7) There must be adequate supplies of scrap steel at a lower price than pig iron, or the arc furnace will not be able to compete.

(8) The arc furnace will probably, apart from the above considerations, tend to replace the acid open-hearth furnace for many purposes.

Engineering in Europe

EXTRACTS FROM FOREIGN TECHNICAL JOURNALS

AN investigation of the flow phenomena in circuit-breakers was carried out on a model breaker, the tank and chamber walls of which consisted of transparent materials, particularly plexiglass, so that not only visual observation and photography of the phenomena, but also their illumination in a direction perpendicular to the line of vision was possible. When the breaker carries no current, the flow lines in the quenching chamber are rendered visible by minute, almost " mass-free " marker particles added to the quenching agent. The flow direction and velocity can be determined from the traces of these particles and the photographic exposure time.

The exposures may be obtained by high-speed (slow-motion) cameras, cameras with slit-type rotary shutters or, best of all, with an image convertor (transducer). The last method is particularly suitable to prevent over-exposure of the sensitive photographic materials by the optically powerful arc. The exposure time was mostly of the order 10 μsec. However, additional illumination was required, because it was obviously necessary to get pictures showing the breaker parts as well as the arc; only flashlights could be used for this purpose. The breaker operation, image convertor, camera shutters and the loop oscillograph, operated simultaneously for obtaining oscillograms defining the arc parameters, and contact speeds were controlled automatically by an electronic programme unit. From the slow-motion pictures obtained on a model of a small oil-volume breaker the flow velocities inside the quenching chamber could be determined as 6-10 m/sec, and those inside the hollow moving contact as 10-16 m/sec, with currents up to 500 A broken at 20 kV.—" Investigations of Flow Phenomena in Circuit-Breakers," F. Remde and H. Tolazzi, *E.T.Z.(A)*, Vol. 76, No. 19, pp. 704-710, 1st October, 1955, in German.

Oil Film Thicknesses

The problem of measuring the thickness of the oil film in plain journal and thrust bearings is obviously important for investigations on friction, wear, lubrication and allied problems arising everywhere in mechanical engineering. However, it is even more important in the case of some modern electrical machines, viz. large hydro-alternators and synchronous motors with vertical shafts, since these, with the possible exception of heavy boring lathes, are the heaviest machines with vertical shafts, the operation of which depends on a very heavily stressed thrust bearing.

A number of methods for measuring the thickness of the oil film have been developed, the first of which was an optical method (1919), and subsequent methods were based on interference, electrical resistance, capacitance and inductance variations. All these methods were unsatisfactory for various reasons; some of them were only suitable for laboratory experiments. The authors' method is based on inductance variations measured by a pick-up of the transformer type, supplied with a commercial frequency voltage, which may remain permanently in position.

The variations of the thickness of the oil film are recorded by a c.r.o., this being very important for the investigation of the effect of transient processes (running-up, running-down and reversal of motors, etc.) on the oil film and the bearing. The results are of a satisfactory accuracy, which may be inferred from comparative temperature, pressure and strain gauge measurements, since the theory of these complex phenomena cannot furnish accurate results for comparison.—" Measurement of the Thickness of the Oil Film in Plain Journal and Thrust Bearings," Ya. I. Kagan, O. I. Bogdanov and E. I. Yantovskii, *Elektrichestvo*, No. 9, pp. 73-76, 1955, in Russian.

Swedish Grid Conductors

The advantages of grouped conductors over single conductors are particularly marked at high transmission voltages and contribute to more favourable field configuration around the conductors (enabling higher voltages to be used), reduction of the line inductance and increase of its capacitance (resulting in increased transmitting capacity), improved corona and radio interference characteristics. Last, but not least, grouped conductors are more favourable from the economic viewpoint for lines operated at 300 kV and over, but in the case of heavily loaded lines even from 200 kV. The experience gathered with 380 and 200 kV lines with twin conductor groups on the Swedish grid is of the greatest importance for all designers of power systems because it shows to the best advantage the qualities claimed for this type of construction, since the operating conditions in the Swedish grid must be regarded as very severe from every point of view.

The loading of the lines is most of the time near the limit of the transmitting capacity, as most of the power consumed by Sweden's industry situated in the south has to be supplied across nearly the whole length of the country, i.e. more than 1,000 miles. Also, snow and ice loading of the lines has to be faced for much longer periods than almost anywhere else. To experiences with these phenomena, and measures to cope with them, the authors devote the greater part of their report, giving details about the types of line equipment, insulators, connectors, spacers and comparative costs of operation of twin-conductor and single-conductor lines. The period of operation reported on extends from 1951 to 1955, and atmospheric conditions and their consequences for the operation of the lines are carefully analysed.—" Grouped Conductors in the Swedish Power Grid." G. Jancke, D. Zetterholm and E. Danielsson, *Tekn. T.*, Vol. 85, No. 32, pp. 709-715, 6th September, 1955, in Swedish.

Harmonics from Mercury Rectifiers

Cases have been known of severe distortions of the waveform of the system voltage where the load included six-phase rectifier installations amounting to about 10-15 per cent of the total system load. Generators and consumers near the rectifier substations, even though the consumers' circuits might be separated from the rectifiers by several transformer stages, were affected by inadmissibly strong 5th and 7th harmonic currents. In such cases the system designer must be able to predetermine, at least approximately, the distortion and harmonic content of voltages and currents.

The paper considers the main cases possible, viz. a single rectifier substation supplied by the busbars of a power station when the system capacitance is negligible; the

rectifier installation at the end of a h.v. transmission line; rectifier substation supplied from busbars in parallel with an idling transmission line; and several rectifier substations supplied through a transmission line or from busbars.

In all these cases, a judicious choice of equivalent circuits enables the harmonic content to be estimated rapidly and conveniently with all the accuracy required. The results are also useful for theoretical considerations of the possibility of increasing the system power or of altering the circuits supplying the rectifier installations. It is seen that in the case of unfavourable relations between line capacitance and generator inductance the 5th harmonic in generator circuits near the rectifiers may reach 15-25 per cent of the rated current, the 7th harmonic 10-14 per cent, much more than permissible. This, in turn, distorts the system voltage and introduces 5th and 7th harmonics into the consumers' circuits. These dangers are effectively obviated by 12-phase rectifier circuits (or even higher phase numbers).—" The Higher Harmonics in a Power System Supplying Mercury Rectifiers," B. G. Orkina, *Elektrichestvo*, No. 2, pp. 41-49, 1955, in Russian.

Magnetic Amplifier Control

The surprisingly rapid and extensive introduction of magnetic amplifier control in a multitude of heterogeneous fields is well described and illustrated by the authors who deal at first with the control of electrical and then of mechanical quantities. In the first group the main applications are voltage regulation on synchronous generators in the frequency range 50-10,000 c/s and for ratings 30 kVA-20 MVA, for electrolytic plants and for heating control of transmitting valves; current control in electrolytic plant, for constant excitation of rolling-mill drive motors and resistance heating of melts; and impedance control in electric arc furnaces.

The mechanical applications are much more numerous and varied, viz. speed control of machine tool drives of any kind and other working machinery, testing machines, high-speed elevators, automatic winding engine drives, etc.; control of speed ratios of multi-motor drives of blooming and looping mill trains and auxiliary drives; control of speed ratio and travel for multi-motor drives of hot strip mill, loop and shape rolling trains; tension control in reel-type rolling mills and winding frames in the textile industry; torque control in twin drives of cogging mills; and position control, particularly control of the over-run in ships' steering gear drives. Of other controlled quantities the temperature control in h.f. heating and resistance furnaces may be the most interesting example given. Typical plants are described and illustrated by diagrams of the control circuits, pictures of the plants and, partly, oscillograms of the control processes.—" Use of Magnetic Amplifier Control in H.V. Installations," M. Tschermak and W. Kafka, *Siemens-Z.*, Vol. 29, No. 9, August, 1955, in German.

L.V. Circuit-Breaking

The author presents a very clear exposition of the physics of the low-voltage arc in air so far as it is of interest to the designer of l.v. switchgear. It is shown that the problem of arc extinction is predominantly a problem of rapid heat transfer; the importance of efficient and rapid cooling of the arc is clearly demonstrated by the fact that at 2,000 deg K a temperature rise of only 30 deg K doubles the ion density in the arc plasma. The relative ineffectiveness of magnetic blow-outs is partly due to the fact that the magnetic field available acts only on the relatively slow ions and not on the fast electrons in the arc plasma. The basic condition of a successful design of arc-quenching chambers is therefore a calculation of the—mainly thermal—arc energy, arc temperature, and the rate of rise of the temperature on the contact faces under the ion bombardment. The pressure rise and electromagnetic field conditions in the arc have also to be considered (the latter for evaluating the " looping " forces acting on the arc and the contact).

A comprehensive series of tests on a 500 V air circuit-breaker with different types of quenching chambers is reported. The rated current was 300 A, but the breaking currents were 1,650 A ($\cos\phi=0{\cdot}34$), 4,200 A and 5,800 A. The arcing phenomena in the various quenching chambers were recorded in slow-motion pictures. It is obvious that the effects of the chambers also depend on current magnitude and phase, but they are not unambiguously determined by number, geometry and material of the partitions of the chamber. Particularly the height of the partitions relative to contact level must be watched, since walls extending above contact level interfere with the arc expansion, scavenging of the hot gases from the chamber and the de-ionization of the break. Also, metal partitions are unsuitable, surprisingly, owing to their high thermal conductivity and the excessive heat exchange with the hot gases, slowing down the exhaustion of the latter from the chamber. Unpartitioned chambers are better than chambers with unsuitable partitions.—" L.V. Circuit-Breaking in Quenching Chambers," F. Houst, *Elektrotech. Obzor.*, Vol. 44, No. 9, pp. 476-486, 1955, in Czech.

Spark-Machining of Metal

The authors, whose name has been associated with work on spark-machining since the original development of the method in 1938 (in the U.S.S.R. they are regarded at least as co-inventors of the method), present a comprehensive report on the present state of the art in the U.S.S.R. The most important fact emerging seems to be that a stage has been reached at which the most promising applications of the method, i.e. those where the method offers specific advantages over the conventional techniques, are more or less known. Some of these are precision drilling, particularly of the bores of nozzles and jets, grinding and slotting work.

A most important special application is the spark-machining of hard alloy dies. Other applications, only loosely referred to as " machining," are surface hardening and various operations in connection with repair work on heavy and cumbrous machinery, including in some cases the cutting out of broken tool-ends from the work and closing the holes by spark-deposition of metal, since one of the particular merits of the method is its dual and complementary character of a cutting *and* deposition process.

According to the authors, the method has found wide application in Soviet industry, although this statement does not really convey much even though various machines designed for special purposes are shown in pictures. These bear out the authors' remark that the transition period in which machine tool designers still work in close analogy with conventional machine types instead of going the radically different ways that the novel idea requires, has not yet come to an end. For this reason one of the main advantages of the method, viz. that of enabling light portable set-ups to be used, is still insufficiently appreciated.—" Electric Spark-Machining of Metals," B. R. Lazarenko and N. I. Lazarenko, *Elektrichestvo*, No. 8, pp. 62-68, 1955, in Russian.

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review*.

Laplace Transformation

An Explanation of its Connection with the Heaviside Calculus

By H. GOLDENBERG, M.Sc.*

MANY engineers are familiar with the basic ideas of Heaviside calculus, but substantially fewer are conversant with the related subject of Laplace transformation. This article presents an elementary account of Laplace transformation as applied to two individual problems, and indicates how the more extensive and more readily available tables of Laplace transforms may be used to find Heaviside pairs not easily obtainable by Heaviside calculus.

The Laplace transform of a function of time, f(t), is denoted by $L\{f(t)\}$ and defined by:

$$L\{f(t)\} = \int_0^\infty e^{-st} f(t)\,dt = F(s) \text{ (say)}$$

where s may initially be regarded as a real constant, sufficiently large to ensure convergence of the infinite integral. The function f(t) is called the inverse Laplace transform of F(s) and is denoted by $f(t) = L^{-1}\{F(s)\}$.

The Laplace transform of the most common functions of time, 1, t, t^2.....t^n, sin wt, cos wt and e^{-kt} are readily obtainable by direct integration, using integration by parts where necessary, and are given in Table 1.

Examples:

(*a*) $L\{t^2\} = 2/s^3$

$\therefore L\{3t^2\} = 6/s^3$ (or in alternative notation $L^{-1}\{6/s^3\} = 3t^2$)

(*b*) $L\{1\} = 1/s^2$ and $L\{\sin 2t\} = 2/(s^2+4)$

$$\therefore L\{t - \sin 2t\} = \frac{1}{s^2} - \frac{2}{s^2+4}$$

$$\text{and } L\{3t - 4\sin 2t\} = \frac{3}{s^2} - \frac{8}{s^2+4}$$

(*c*) $L\{e^{-kt}\} = 1/(s+k)$

$$\therefore L\{-te^{-kt}\} = \frac{d}{ds}\frac{1}{(s+k)} = -\frac{1}{(s+k)^2}$$

$$\therefore L\{te^{-kt}\} = \frac{1}{(s+k)^2}$$

(*d*) $L\{\sin wt\} = w/(s^2+w^2)$

$\therefore L\{e^{-\alpha t}\sin wt\} = w/[(s+\alpha)^2 + w^2]$

To illustrate the method of application of Laplace transformation in an individual case, consider the following example (see Fig. 1).

Example 1:

A constant e.m.f. E is applied at time t = 0 to the coupled circuits shown, where the mutual inductance M is given by $M^2 = L_1L_2$. The cyclic currents shown are initially zero. Find the current in the primary circuit at any subsequent time.

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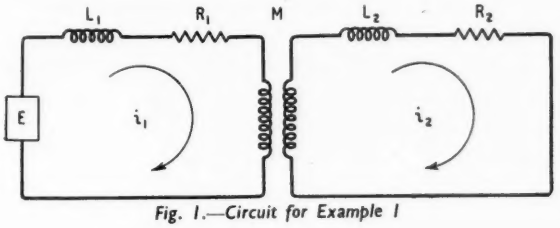

Fig. 1.—Circuit for Example 1

TABLE 1.—BASIC TABLE OF LAPLACE TRANSFORMS

f(t)	F(s)
1	1/s
t	$1/s^2$
t^2	$2/s^3$
t^n	$n(n-1)(n-2)\ldots\ldots/s^{n+1}$
sin wt	$w/(s^2+w^2)$
cos wt	$s/(s^2+w^2)$
e^{-kt}	$1/(s+k)$

This table of Laplace transforms may be considerably extended using operation rules, the most important of which include the following:—

TABLE 2.—BASIC TABLE OF OPERATION RULES

Operation to be performed on f(t)	Operation to be performed on F(s)
Multiplication by constant k	Multiplication by constant k
Addition (or subtraction) of two or more independent f(t)	Addition (or subtraction) of the two or more corresponding F(s)
Multiplication by $-t$	Differentiation with respect to s
Multiplication by $e^{-\alpha t}$	Replacement of s by $s+\alpha$

The differential equations giving the cyclic currents i_1 and i_2 are:—

$$L_1\frac{di_1}{dt} + R_1 i_1 + M\frac{di_2}{dt} = E$$

$$L_2\frac{di_2}{dt} + R_2 i_2 + M\frac{di_1}{dt} = 0$$

and on multiplication throughout by e^{-st} and integration from t = 0 to t = ∞ give:

$$L_1\int_0^\infty e^{-st}\frac{di_1}{dt}\,dt + R_1\int_0^\infty e^{-st} i_1\,dt + M\int_0^\infty e^{-st}\frac{di_2}{dt}\,dt = E\int_0^\infty e^{-st}\,1\,dt$$

$$L_2\int_0^\infty e^{-st}\frac{di_2}{dt}\,dt + R_2\int_0^\infty e^{-st} i_2\,dt + M\int_0^\infty e^{-st}\frac{di_1}{dt}\,dt = 0$$

or when expressed in Laplace transform notation, using $L\{f(t)\} = \int_0^\infty e^{-st} f(t)\,dt$, give:

$$L_1 L\left\{\frac{di_1}{dt}\right\} + R_1 L\{i_1\} + ML\left\{\frac{di_2}{dt}\right\} = EL\{1\}$$

$$L_2 L\left\{\frac{di_2}{dt}\right\} + R_2 L\{i_2\} + ML\left\{\frac{di_1}{dt}\right\} = 0$$

Denote $L\{i_1\} = \int_0^\infty e^{-st} i_1\,dt = I_1(s)$ or, more briefly, I_1

$L\{i_2\} = \int_0^\infty e^{-st} i_2\,dt = I_2(s)$ or, more briefly, I_2

Then $$L\left\{\frac{di_1}{dt}\right\} = \int_0^\infty e^{-st}\frac{di_1}{dt}\,dt$$

$$= [e^{-st} i_1]_{t=0}^{t=\infty} + s\int_0^\infty e^{-st} i_1\,dt$$

Now s may generally be assumed sufficiently large for

the product $e^{-st} i_1$ to tend to zero as $t \rightarrow \infty$, while in the present example the current $i_1 = 0$ when $t = 0$.

$$\therefore L\left\{\frac{di_1}{dt}\right\} = sI_1$$

Similarly $L\left\{\frac{di_2}{dt}\right\} = sI_2$

Further, from Table 1, $L\{1\} = \frac{1}{s}$

The Laplace transform of the original differential equations therefore takes the form:

$$L_1 sI_1 + R_1 I_1 + MsI_2 = E/s$$
$$L_2 sI_2 + R_2 I_2 + MsI_1 = 0$$

These equations could be written down directly when sufficient familiarity is obtained with the Laplace transform method. On rearrangement of terms, the equations become:

$$(L_1 s + R_1)I_1 + MsI_2 = E/s$$
$$Ms\, I_1 + (L_2 s + R_2)I_2 = 0$$

Two important points to be noted at this stage are that the differential equations have been transformed to simple algebraic equations and that the boundary conditions of zero initial cyclic currents have already been incorporated in the working.

The elimination of I_2 between the above equations gives:

$$I_1 = \frac{EL_2}{L_1R_2 + R_1L_2}\,\frac{(s + \alpha)}{s(s + \beta)}$$

where $\alpha = R_2/L_2$

$$\beta = R_1R_2/(L_1R_2 + R_1L_2)$$

which in partial fractions gives:

$$I_1 = \frac{EL_2}{L_1R_2 + R_1L_2}\left[\frac{\alpha}{\beta}\,\frac{1}{s} - \frac{(\alpha - \beta)}{\beta}\,\frac{1}{(s + \beta)}\right]$$

$$\therefore i_1(t) = L^{-1}\{I_1(s)\}$$

$$= \frac{EL_2}{L_1R_2 + R_1L_2}\left[\frac{\alpha}{\beta}L^{-1}\left\{\frac{1}{s}\right\} - \frac{(\alpha - \beta)}{\beta}L^{-1}\left\{\frac{1}{s + \beta}\right\}\right]$$

Using Table 1 for standard forms,

$$L^{-1}\left\{\frac{1}{s}\right\} = 1 \text{ and } L^{-1}\left\{\frac{1}{s + \beta}\right\} = e^{-\beta t}$$

$$\therefore i_1(t) = \frac{EL_2}{L_1R_2 + R_1L_2}\left[\frac{\alpha}{\beta} - \frac{(\alpha - \beta)}{\beta}e^{-\beta t}\right]$$

$$= \frac{E}{R_1} - \frac{EL_1R_2}{R_1(L_1R_2 + R_1L_2)}\,e^{-R_1R_2t/(L_1R_2 + R_1L_2)}$$

Connection between Laplace Transformation and Heaviside Calculus

Given any Heaviside pair

$$H(p)1 = h(t)\,1$$

the corresponding Laplace transform pair is obtained by replacing p by s, and replacing 1, the "coefficient" of H(p), by 1/s or $L\{1\}$, so that in Laplace transform notation

$$L^{-1}\left\{\frac{H(s)}{s}\right\} = h(t)$$

The solution of example 1 in Heaviside notation would, therefore, be

$$\frac{EL_2}{L_1R_2 + R_1L_2}\,\frac{(p + \alpha)}{(p + \beta)}\,1$$

In practice it is usually much easier to obtain the time function h(t) from extensive Laplace transform tables, (1, 2, 3, 4) with occasional use of an operational table such as presented earlier, (1, 2, 3, 4) than to use the limited tables of Heaviside pairs that are available. In particular the tables at the back of Gardner and Barnes' book (4) should prove adequate if the form of the function H(p) is limited to the ratio of two polynomials in p, as is the case with most linear network problems.

Example 2:

Consider a transmission line of surge impedance z, with a linearly rising current $i = kt$ (t = time in seconds) injected into one end of the line and with an inductance L terminating the other end of the line (Fig. 2). Find the voltage build-ups at the sending end of the line involving up to two reflections at the termination of the line.

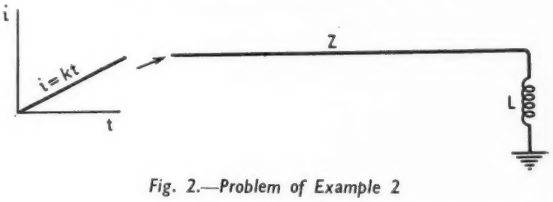

Fig. 2.—Problem of Example 2

From Bewley (5) the reflection factor at the junction of the line and inductance is $(pL - z)/(pL + z)$ and the operational forms of the successive voltage build-ups at the sending end of the line commencing at times 0, $2t_0$, and $4t_0$ are:

$$\frac{kz}{p}\,1,\ \frac{2kz}{p}\left(\frac{pL - z}{pL + z}\right)1 \text{ and } \frac{2kz}{p}\left(\frac{pL - z}{pL + z}\right)^2 1$$

where t_0 is the time in seconds for a wave to travel the length of the line, namely the length of the line in miles divided by 186,000.

In Laplace transform notation therefore the voltage build-ups are

$$kzL^{-1}\left\{\frac{1}{s^2}\right\},\ 2kzL^{-1}\left\{\frac{1}{s^2}\left(\frac{sL - z}{sL + z}\right)\right\} \text{ and}$$

$$2kzL^{-1}\left\{\frac{1}{s^2}\left(\frac{sL - z}{sL + z}\right)^2\right\}$$

Using Table 1, the first voltage build-up is kzt.

From Gardner and Barnes' tables (4*a*) the second voltage build-up is given directly by:

$$2kz\left[\frac{2}{\alpha}(1 - e^{-\alpha t}) - t\right] \text{ where } \alpha = z/L$$

From Gardner and Barnes' tables (4*b*) the third voltage build-up is given directly by:

$$2kz\left[+4te^{-\alpha t} - \frac{4}{\alpha}(1 - e^{-\alpha t}) + t\right]$$

Further applications of Laplace transformation

The field of application of Laplace transformation in general is very wide, linear ordinary and partial differential equations subject to boundary conditions given at zero time being especially susceptible to this method. In particular its use is well established in the fields of electric circuit theory, transmission lines, wave and diffusion problems, heat conduction and hydrodynamics. Finally the method has been applied with success in the solution of integral equations, the summation of infinite series and the solution of differential-difference equations, the latter arising especially in servo-mechanism theory.

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Pressurized-Water Reactors

A Heat Source for Steam Power Plants

IN his James Clayton Lecture on nuclear reactors and power production last year Sir Christopher Hinton spoke of the probable development of several different types of nuclear reactor, forming a sequence in ascending order of thermal rating and descending order of core size. At one end of the scale there is the graphite-moderated gas-cooled reactor of the Calder Hall type. At the other extreme there is the plutonium-fuelled fast-fission reactor.

The graphite-moderated gas-cooled reactor is already being developed for widespread use during the first stage of the United Kingdom's nuclear power programme. It has many advantages, particularly in its ability to use natural uranium and in its inherent safety. When by-product plutonium becomes available in quantity from the early nuclear reactors, however, it will be desirable to have other reactors following on, which will be suitable for burning the by-product plutonium in conjunction with natural or depleted uranium in the most efficient way. Among the more promising possible types of thermal reactor which could be developed for use during this second stage are the sodium-cooled graphite reactor and the pressurized water-moderated reactor.

In a paper by Dr. J. M. Kay and Mr. F. J. Hutchinson (both of Kennedy & Donkin, Ltd.), which was presented at a general meeting of the Institution of Mechanical Engineers in London last week, the pressurized water reactor is examined from the viewpoint of the power plant engineer and some of the different ways in which it could be employed as a source of heat for a steam power station are considered.

The description " pressurized water reactor " is taken to include both light-water- and heavy-water-moderated reactors employing a pressurized-water-cooling system. The general engineering features would be similar in either case. A heavy-water-moderated reactor, however, is capable of using natural uranium provided a calandria type of construction is employed, so that most of the moderator can be maintained at high density and, because of the rather open lattice arrangement required, it involves a rather larger diameter of core. A light-water-moderated reactor on the other hand must be fuelled either with enriched uranium or with a mixture of uranium and plutonium, and the ratio of moderator volume to fuel volume is much smaller than with the heavy-water reactor.

The core of a pressurized-water reactor will consist of a cylindrical assembly of fuel elements arranged in lattice formation and housed inside a pressure vessel. Each fuel element will normally be placed inside a coolant channel or duct, and water will be circulated at a fairly high velocity to secure the required rate of heat removal. The moderator and coolant water must normally be pressurized to prevent the occurrence of boiling inside the core.

It is a feature of every type of nuclear reactor that the fuel element presents the most difficult problem of any part of the design. The fuel itself may take the form of metallic uranium, an alloy of uranium, or the oxide UO_2. As in the case of other reactors, the fuel must be protected by means of a can or sheath to prevent oxidation (in the case of metallic fuel) and to prevent the escape of fission products.

Pressurized-water reactors are sometimes compared unfavourably, with either gas-cooled or sodium-cooled reactors, on the basis of the available coolant outlet temperature. This, however, is not a valid basis for comparison. With water-cooled reactors temperatures throughout the core are more nearly uniform than in any other known type of reactor. The boiler pressure is determined by the coolant return temperature and not by the outlet temperature. In terms of steam conditions and cycle efficiencies, the pressurized-water reactor appears in a much more favourable light.

The principal merit of the water-moderated reactor is the prospect that it offers of meeting a wide range of power station requirements with a single basic type of design. Once having solved the characteristic engineering problems of a pressurized-water system, a number of variations in design become possible without meeting new problems on each occasion. If heavy water is available, natural uranium may be used as the fuel. If enriched fuel is available, ordinary water may be used as the moderator and, by increasing the degree of enrichment successively, smaller reactor cores may be employed. A very wide range of power output can thus be covered from the same basic design. Finally, there is the prospect of development from the orthodox pressurized-water reactor to some form of boiling-water reactor.

The real criterion as to whether one type of nuclear reactor is better than another will be reliability and convenience of operation rather than the efficiency or even the cost of the plant. A decision on this point can be made only in the light of actual operating experience. The best type of liquid-cooled reactor will probably be the reactor having the simplest type of fuel element, and preferably a fuel element which will deteriorate only slowly in the event of a minor imperfection or failure in the sheath.

Nuclear Energy Committee

THE Council of the Institute of Metals has appointed a Nuclear Energy Committee with the object of stimulating interest in metallurgical problems arising in connection with the industrial and scientific aspects of the use of nuclear energy. It is proposed that, among its activities, the new Committee shall arrange special meetings, discussions and symposia; invite the writing of papers or articles for publication; and arrange the publication of books or other literature to attain the objects for which it was formed. The Committee hopes to arrange an exhibition of nuclear energy products, of interest to metallurgists, in connection with the Institute's Spring Meeting in April, 1956.

The constitution of the Committee is: Mr. G. L. Bailey (British Non-Ferrous Metals Research Association); Mr. E. W. Colbeck (Hadfields, Ltd.); Dr. M. Cook (Imperial Chemical Industries, Ltd., Metals Division); Dr. S. F. Dorey (Lloyd's Register of Shipping); Dr. H. M. Finniston (United Kingdom Atomic Energy Authority); Dr. Ivor Jenkins (General Electric Co., Ltd.); Professor A. G. Quarrell (University of Sheffield); Mr. L. Rotherham (United Kingdom Atomic Energy Authority); Mr. S. S. Smith (Imperial Chemical Industries, Ltd., Metals Division); and Major P. L. Teed (Vickers-Armstrongs (Aircraft), Ltd.).

Persons who are interested in the activities of the Committee should communicate with Lieut.-Colonel S. C. Guillan, secretary, Institute of Metals, 4, Grosvenor Gardens, London, S.W.1.

Dissolved Oxygen Recorder

Measurement of Low Concentrations

A NEW electro-chemical type of dissolved oxygen recorder for measuring accurately the low concentrations of dissolved oxygen in boiler feed water for turbo-generator sets has been produced by the Cambridge Instrument Co., Ltd., 13, Grosvenor Place, London, S.W.1. The range of the outfit is 0-100 microgrammes per litre (0 to 0·1 parts per million) and a second range of 0-500 microgrammes per litre (0 to 0·5 parts per million) can be provided to enable the record to be brought on scale during fault conditions.

The analysing unit is based on an adaptation of polarographic principles. It depends upon the fact that a small potential applied between two suitable electrodes immersed in water, which has been rendered conducting, will produce a current whose value depends upon the concentration of reducible substances in the water. The value of the potential determines which substances will produce a current. By using two cells with two different potentials, it is possible to obtain two currents, one of which is proportional to the concentration of certain impurities and the other proportional to these impurities plus dissolved oxygen. The difference beween the two currents, which can be recorded, is thus a measure of dissolved oxygen only. The effect of traces of copper and ferric salts, which are the most common impurities in boiler feed water, is virtually eliminated. With the exception of lead, other common metals in solution do not interfere and this also applies to feed water additives such as soda, phosphates, sulphites and hydrazine. The probability of interference by other additives can be determined readily by polarographic tests.

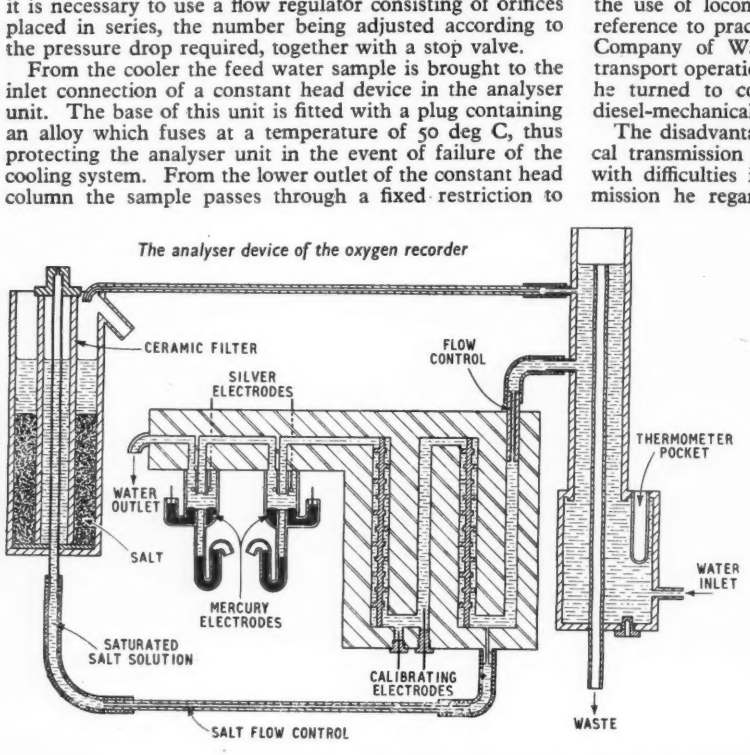
The equipment consists of four units, namely, the cooler and flow control valve, analyser unit, control panel and recorder. The type of cooler and control valve depends on the condition of the individual plant. Where the sample supply pressure is not more than 100 lb/sq in a needle valve is employed but where the pressure exceeds this figure it is necessary to use a flow regulator consisting of orifices placed in series, the number being adjusted according to the pressure drop required, together with a stop valve.

From the cooler the feed water sample is brought to the inlet connection of a constant head device in the analyser unit. The base of this unit is fitted with a plug containing an alloy which fuses at a temperature of 50 deg C, thus protecting the analyser unit in the event of failure of the cooling system. From the lower outlet of the constant head column the sample passes through a fixed restriction to provide a constant flow and then through two U tubes in series.

At the bottom of the first U tube a salt solution is injected through a small nozzle, thus rendering the sample water conductive. A reservoir for the salt solution is provided by a small tank containing a tubular ceramic filter to the interior of which is connected the salt injection line. Salt crystals are added around the filter and the reservoir is continuously supplied with water from the upper outlet of the constant head column, thus providing a saturated salt solution at a pressure slightly in excess of that of the sample, giving a constant injection rate. The sample then passes through a series of baffles to ensure complete mixing of the salt solution, to the bottom of the second U tube which contains two platinum electrodes, for calibrating the apparatus, as described later. From this point the sample passes through further mixing baffles to the first of the two glass analysing cells. Each cell has an upper electrode of silver and a lower electrode formed by a pool of mercury. Inlet and outlet connections for the mercury electrode are provided by small U tubes enabling the mercury to be changed without admitting air to the analysing cell.

The sample passes from the first cell through the second cell and then to waste. Differing potentials are applied to the two analysing cells from small dry batteries of the U2 type universally available. When the selector switch on the control panel is in the "on" position, the recording system, which is calibrated directly in terms of concentration of dissolved oxygen, measures the difference between the currents in the two cells. Provision is also made on the control panel for standardizing the potentials applied to the cells, and a sensitivity adjustment is provided for check calibration of the analyser unit. A 90 V dry battery for the calibration system is mounted on the panel and is isolated by a double pole switch when not in use.

The analyser device of the oxygen recorder



Works Locomotives

IN a paper presented before the Institution of Locomotive Engineers on 14th December, Mr. C. Wordsworth reviewed the use of locomotives for heavy industry with particular reference to practice at the Port Talbot works of the Steel Company of Wales. After describing the conditions of transport operation and the types of steam locomotives used, he turned to consider their progressive supersession by diesel-mechanical and diesel-electric units as from 1946.

The disadvantages of the relatively inexpensive mechanical transmission were noise and inflexibility on gradients with difficulties in gear changing. Diesel electric transmission he regarded as ideal from the operation standpoint and it was popular with the crews. Its simple controls and stepless tractive effort curve made it extremely flexible for general duties. For maintenance it required an additional grade of craftsmen, but experience showed that major electrical work, such as stripping of generators and motors, was needed only once in eight or nine years; even then the only attention often required was skimming of commutators and general cleaning.

The locomotive itself might be scrapped as obsolete before the electrical machines needed complete rebuilding. Recently two new types of diesel-electric locomotives had been introduced, one of 300 h.p. for shunting on the level and another of 500 h.p. to undertake other duties, both with a maximum speed of 28 m.p.h. A larger unit of 600 h.p. was being ordered to propel five heavy slag wagons, weighing 850 tons gross, up a gradient of 1 in 70 round a 339ft radius curve.

275 kV Switching Station

DRAKELOW INSTALLATION TO CONTROL FOURTEEN CIRCUITS

WE understand that the Drakelow switching station on the Drakelow-Staythorpe transmission line of the 275 kV supergrid was recently commissioned and A. Reyrolle & Co., Ltd., have sent us the following description of the station, which will ultimately be one of the biggest in the United Kingdom, covering an area of more than 54,000 sq yd, and controlling 14 circuits. Seven of the circuits are already installed.

The station is of the low double busbar type, the busbars being of 3in diameter rigid copper tube carried by the isolator and the intermediate post insulators. The isolators and post insulators are mounted on reinforced concrete pedestal structures to give the necessary ground clearance to the busbars, while the circuit connections are in the form of flexible conductors, crossing above and at right-angles to the busbars and strained between reinforced concrete " A " frames. Riser connectors from the busbar selector isolators and down-dropper connectors to the circuit-breaker and its associated equipment complete the circuit connections.

At present the main and reserve busbars are each single section, with a busbar coupler circuit-breaker provided between them, but ultimately the main busbar will be divided into three sections serving busbar section and busbar coupler circuit-breakers. Circuit-breaker by-pass isolators are not provided, but there are facilities to by-pass a circuit-breaker by flexible conductor loops and to isolate it by removing connector sections. The circuit can then be controlled by the busbar coupler circuit-breaker and extended maintenance of the circuit-breaker can be undertaken, if required, while the circuit is still in commission.

Air-Blast Circuit-Breakers

The circuit-breakers are of the Reyrolle type 2750B30, and of the air-blast design with 1,200 A maximum carrying current and 7,500 MVA making and breaking capacities. They are mounted on reinforced concrete pedestal supports to give the necessary clearance from live metal to earth to avoid the need for safety screenwork.

Each phase of each circuit-breaker is identical, but all three phases are coupled together by series break arm operating shafts and by suitable air piping. These ensure that all three phases operate simultaneously, when required to operate, even in the event of a failure of the closing or tripping valves of any phase. Each phase consists of three hollow support insulators mounted on a common bedplate, each with a porcelain blast pipe inside and each surmounted by two interrupted units in " V " formation, so that there are six circuit interrupters in series per phase. Correct voltage distribution across the breaks is obtained by shunting each break by a suitable tubular condenser which also forms part of the blast tube to the circuit-breaking contact and nozzle assembly.

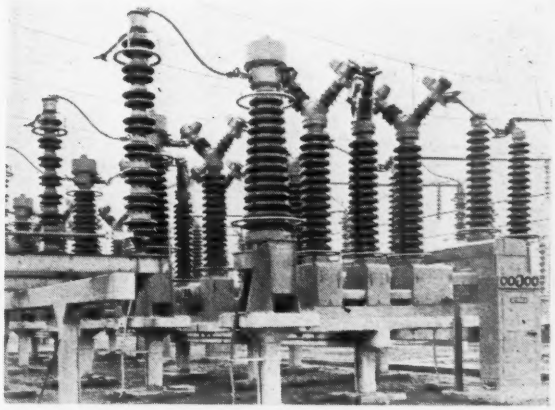
There are three blast valves per phase, all coupled together by a heavy section tubular torque shaft and operated by a single piston type air motor. The compressed air is stored at 330 lb/sq in gauge in one receiver per phase and is controlled by a compact pilot valve arrangement initiated by a relatively small operating magnet. Air economy is maintained by a change-over valve operated by the series isolator mechanism which, when the isolator is opened sufficiently, transfers the air pressure to the other side of the blast valve motor and closes it rapidly.

The series break sequential isolator, which is an integral part of the circuit-breaker, is of the centre rotating type and bridges the gap from the end interrupter to a terminal post carried on the bedplate. The series break isolator arm is carried by a porcelain insulator rotated by a double acting piston type air motor which is supplied with air, when opening, from the nearest blast pipe of the circuit-breaker so that it only operates after the blast valve is opened. In closing, the circuit is made on the series sequential isolator at an appropriate speed. The closing valve is identical with the tripping pilot valve. Adequate interlocks are provided in the air system to prevent mal-operation of the circuit-breaker under all conceivable operating conditions.

Prevention of Contamination

The inside of the circuit-breaker presents many plain insulation surfaces in air, and precautions have been taken to prevent any contamination of these surfaces. The first precaution is that there is no insulation in close proximity to the arc, which is completely contained in its own metal chamber; and the nearest insulation is some distance from the arc on the " windward " side of the air blast so that there can be no contamination from the products of the arc. The second precaution is that as far as possible only porcelain is used for insulation, including the main blast pipes. The only bakelized paper insulation used is that in the voltage distribution condenser which is of the highest quality non-hygroscopic type. Thirdly, the whole of the internal insulation surfaces are continually swept by very dry conditioning air which is expanded from the storage pressure to a few pounds above atmospheric pressure.

All the controls and air system isolating valves, the pressure gauge, conditioning-air reducing valve, choke and conditioning-air flow-indicator, local-remote change-over switch, automatic shut-down valve, emergency trip-valve, supply fuses and links, etc., are contained in a separate



The 275 kV air-blast circuit-breakers in the switching station on the Drakelow-Staythorpe transmission line

floor-mounting control cubicle mounted parallel to one phase of the circuit-breaker.

The isolators are products of the General Electric Co., Ltd., made to a standard design developed for the Central Electricity Authority, and they are of the double rotating, two-post design, with a special ball and socket type of high-pressure contact. They are all provided with power operation mechanism and the busbar selector isolators are arranged in tandem while the three phases of the circuit isolators are ganged side by side.

Only the busbar selector isolators are arranged for remote operation from the control room, but they are all fully interlocked with the circuit-breakers to prevent their operation unless the appropriate circuit-breaker is open.

The current transformers are of Reyrolle manufacture and are of the post type mounted independently of the circuit-breaker. The primary conductor is of "U" formation, fully insulated for the system voltage with condenser grading layers and a metal earth screen. The cores and secondary windings are of the orthodox continuous ring type mounted in a steel chamber over the bottom section of the "U" primary, the top end of which is contained in a single porcelain insulator surmounted by a metal connection chamber. The whole assembly is vacuum dried and condenser type oil filled, and the top chamber is provided with a nitrogen sealing device in which a breather is incorporated. Four or five independent secondary windings are provided for instrumentation and protection services, with suitable tappings and test windings to give the maximum facility for interchangeability and for site testing.

These, too, are of Reyrolle manufacture and are of the capacitor type; they are more compact than the electromagnetic kind and have a high impulse strength. The actual transformer core and winding assembly are relatively small since it is designed for operating at a much lower voltage than the line voltage, and is coupled to the line by means of a capacity divider which is incorporated in the construction and is connected between line and earth. The condenser section between the transformer primary h.v. winding and the line is contained in two separate oil-filled porcelain housings mounted above the earthed metal chamber which accommodates the transformer and the condenser connected between the h.v. winding and earth, i.e. in parallel with the h.v. winding. The metal chamber is filled with oil, but it has two air-filled sections with access covers in which are accommodated the spark gap device and the secondary terminals and fuses.

The compressed air for operating and conditioning the circuit-breaker internal insulation is obtained from sets of 30 cu ft/min air compressors which deliver air at a pressure of 600 lb/sq in gauge to main storage cylinders, each of 38 cu ft actual capacity. The air is stored at a higher pressure than the operating pressure for the circuit-breakers, so that the risk of water condensation in the 300 lb/sq in pipework and local receivers is practically eliminated; also the reserve storage capacity is thereby considerably increased and the rate of re-filling the local air receivers is considerably accelerated. The local air receivers are sufficient for two trip make and break operations per circuit-breaker and the main air receivers provide additional capacity which is available to any circuit-breaker which requires it. The compressors are automatic in operation and automatic valves at the circuit-breakers and in the compressor house, with appropriate alarms, provide continuous supervision and protection against faults which might develop in the air system, so that there is no danger of the switchgear being rendered impotent in consequence of air failure.

The switchgear is controlled from the generating station by 110 V direct electrical control. The control board is of the cubicle type with separate control cubicles for each circuit with a mimic diagram and the usual instrumentation and synchronizing facilities. The protective relays are mounted as separate protection cubicles, accommodated in the auxiliary plant building on the switchgear site.

DIESEL ENGINE PERFORMANCE

THE annual report on working costs of heavy oil engines compiled by the Diesel Engineers' and Users' Association relates to returns made for ninety-four installations. Of the seventy-six electric power stations included, forty in Britain (sixteen Central Electricity Authority and six North of Scotland Hydro-Electric Board) generated 108 million kWh and thirty-six abroad generated 398 million kWh.

All users of h.d. oils reported reductions in ring sticking and consequently longer intervals between overhaul. Few oil companies, however, certified that their oils conformed to B.S. 1905. Five home stations made some use of waste heat, but the capital cost incurred was considered unjustifiably high except at very high load factors. The lowest fuel consumption, 0·487 lb/kWh, was achieved by the Benghazi station of the Cyrenaica Government. Lubricating oil consumption rate ranged from 786 to 8,940 b.h.p. hr/gal.

Particulars of performance are summarized in the accompanying table. In most cases conditions, such as load factor, were not conducive to attainment of the best results.

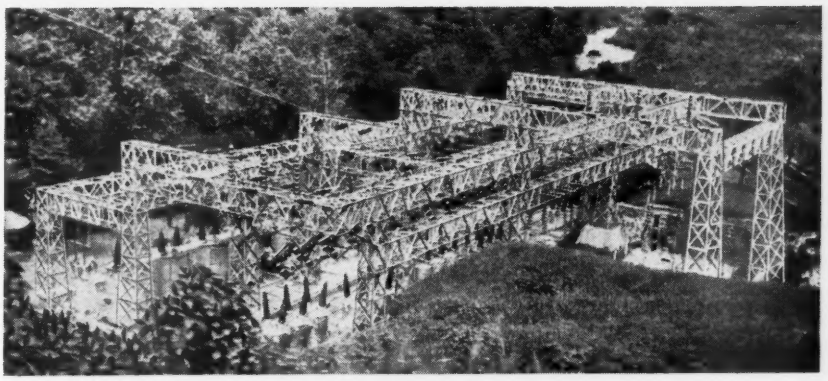
A gas turbine is included for the first time in the report. This is the open-cycle 3,500 r.p.m. unit at Nairobi station of the East African Power & Lighting Co., driving a 2,200 kW 1,500 r.p.m. alternator. The single-shaft turbine has nine reaction stages and is equipped with a heat exchanger; maximum inlet temperature is 1,200 deg F. Figures of performance are not included in the returns as the set ran on test for only 62 hours, during which it generated 98,000 kWh with a fuel consumption of 1·15 lb/kWh, costing 0·697d. Auxiliaries took 0·6 per cent of the kWh generated. Fuel of 18,430 B.Th.U./lb (gross) and sp.g. 0·94 cost £11 12s per ton; its sulphur content was 2·3 per cent and vanadium was believed to be below 30 parts per million. Loading of the turbine was governed by the high and varying temperature of the ambient air, which caused differences of 200 and 400 kW within 24 hours. Lubricating oil consumption was said to have been negligible. A hard deposit $\frac{1}{8}$in thick on some h.p. blades after 2,000 hours of total running was difficult to remove. No signs of corrosion or pitting were observed on any blade.

SUMMARY OF RESULTS—GENERATING STATIONS

	Home			Overseas		
	Max.	Min.	Av.	Max.	Min.	Av.
Fuel oil, kWh/lb ...	1·830	0·507	0·646	0·784	0·487	0·598
Lub. oil, rated b.h.p. hr/gal	8,940	826	2,840	6,240	786	2,295
Costs, d/kWh:						
Fuel	1·322	0·650	0·922	1·503	0·137	0·913
Lub. oil	0·167	0·011	0·055	0·152	0·027	0·084
Stores and water ...	0·102	0·001	0·017	0·258	0·001	0·040
Running wages ...	2·890	0·048	0·465	1·552	0·044	0·245
Repairs & main. ...	1·160	0·019	0·268	1·733	0·038	0·216
Total	4·548	0·889	1·727	3·535	0·533	1·498
Running plant load factor, per cent ...	112·0	38·6	71·0	91·8	34·0	68·2

FROM A CORRESPONDENT IN MEXICO

Mexican Rural Electrification



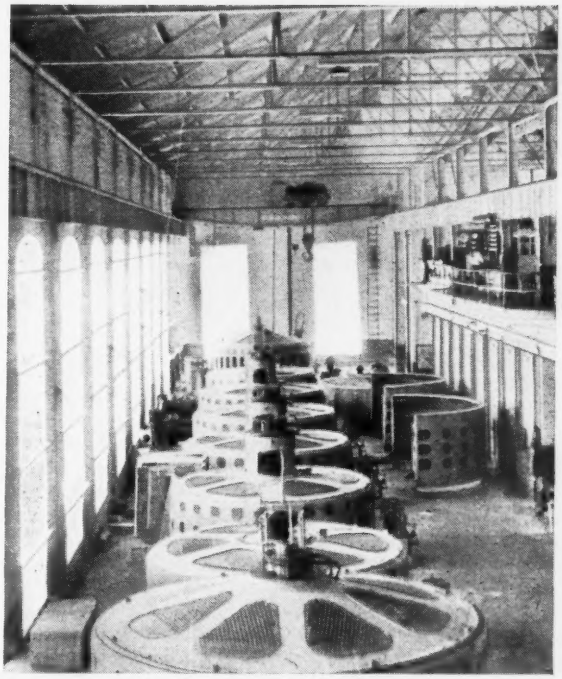
THE Mexican electrification programme, after a decade of construction, has achieved duplication of generating equipment in the central area of the Republic, with sufficient power for urban and industrial centres. With Mexico's generating capacity certain to reach the 2,000 MW mark before the end of the current administration (1958), according to Carlos Ramirez Ulloa, head of the Federal Electricity Commission, the time has come to plan for intensification of the rural electrification programme.

Projects inaugurated during this year will raise the capacity to 1,900 MW. The Federal Electricity Commission will spend a total of 520 million pesos (about £15 million) this year, the largest annual budget approved for electrification projects to date.

The major generating plant scheduled for inauguration this year is the El Cobano in the Tepalcatepec Basin in the State of Michoacan. This 52,000 kW plant will benefit a wide area of the States of Michoacan, Guanajuato, Queretaro, San Luis Potosi and Jalisco. Other plants which will be completed include the El Durazno station of the Ixtapantongo system, with 18,000 kW capacity; San Bartolo (22,000 kW); Coalcoman in Michoacan (600 kW); Colotlipa in Guerrero (2,500 kW); and Fresnillo, Zacatecas (1,000 kW). A thermal plant in Merida, now under construction, will have a 6,000 kW capacity.

While part of the current year's programme is still the expansion of the electrical system in the major central area of Mexico (El Durazno and San Bartolo), other projects aim at providing power in wide rural areas. The Mexican population is reaching 30 million, and 15 million have yet to receive the benefits of electricity. Mexico is a poor country, with very low standards of living. To remedy this the administration has launched its twin agricultural-industrial drive, in which electricity plays an important part. Electrification in Mexico has been rising at an annual average rate of 7 per cent, while the population has increased by 3 per cent.

According to Mr. William H. Draper, jun., chairman of the Mexican Light & Power Co., reserve power for the growing needs of the country's industry and people (for the populated central plains) is greater than at any time in the company's 50 years of service. The recent inauguration of the Patla plant has raised the company's generating capacity to 489 MW. It is now felt that the central zone has sufficient capacity to meet growing needs until 1958, and possibly until 1960. However, the company realizes that constant increases in consumption will make it necessary to invest 2,300 million pesos (about £66 million) in the next decade to double its capacity.



The Necaxa power plant of the Mexican Federal Electricity Commission and (above) the substation of the Necaxa undertaking

After ten years of concentration on the needs of major populated and industrial areas, Mexico enters a new phase in electrification: the nation-wide programme which, within the next four years, and at an expenditure of two billion pesos (£57 million) or more, aims at serving the extensive Gulf and Pacific Coasts with a foundation power network. The vast central area will face soil exhaustion within the next two decades. The initial plans for a vast transfer of farm activity to the lush, fertile coastal regions has already been drawn up.

Primarily, Mexico is a nation that has always had a tremendous number of small rural communities, ranging from three to six *chozas* or huts housing a maximum of 50 persons to villages having a population of from 500 to 2,500. Actually, the Republic has 89,593 localities inhabited by 2,500 persons or fewer. Here live 57·58 per cent of the Republic's population, or 14·8 million people by the 1950 census. The rest of the Mexicans (or 10·9

million) live in 1,010 centres having more than 2,500 inhabitants. These figures have probably increased by approximately three million because of the steady increase of population.

The 70,000 communities with 300 or fewer people are generally formed by indigenous and lower *mestizo* (half-breed) groups who are essentially nomadic, abandoning their *rancherias* (communal dwelling centres) and moving on to a new locality. This is the main problem in rural electrification for the wandering of roughly 7·5 million people makes it impossible to plan improvements such as water, drainage and lighting. The Government is studying plans to consolidate this restless population. A very small stabilization was noted in the last census, with a reduction in the smaller communities and a slight rise in urban centres. This is a trend the Government is trying to foster. The intention is to provide electrical energy for domestic use and to aid in the expansion of agriculture. At the same time, of course, industrial development will benefit, but this is secondary in the present administration's plans to bring electricity to the rural population.

An attempt will be made, where possible, to group together three or more population centres not too far apart from each other, to make up the basic 2,500 people which will make electrical service practicable. Advance studies have shown that at least 5,000 of these centres of population can be incorporated into small electrical systems that will form subdivisions of the overall coastal divisions. Education and investment will be necessary to make it possible for this segment of rural dwellers, who have never seen an electric lamp, to use energy to the best advantage of the community.

At present, Mexico has 1,820 villages, towns and cities where electric service is normal. These centres scarcely make up 2·2 per cent of the total number of communities in the Republic. The short-term goal will be to electrify the 8,500 urban centres having a total of 2,500 citizens or more. These localities account for about 20 million inhabitants, half of whom are without the benefits of electricity. A further five million may eventually receive power when the consolidation of Indian villages is achieved (the administration admits this is a long-range goal), leaving some three million Indians in isolated and out-of-the-way areas who will live as they have in the past.

The majority of the present communities of under 500 inhabitants which already have power obtain it from small local systems or are near the large electrification projects. The Mexican Light & Power Co., whose sphere of activity is the central plateau, has found it profitable to incorporate villages and towns along the routes of its transmission lines into its service. In its plan of expansion for the next decade, this company will pay greater attention to rural electrification. The same holds true for private power companies in Northern Mexico and Vera Cruz. It is the aim of the Federal Electricity Commission to see that electrification develops evenly in all areas.

In certain of the smaller communities, the plan will be to provide local generating facilities so that energy can be provided as economically as possible and the Federal Electricity Commission structure does not become top-heavy and unwieldy. Therefore, private initiative in the electrification of smaller communities will receive the Government's blessing and even subsidies in the form of tax exemptions. Once small electrification projects have developed to a reasonable size they will be incorporated into the large national systems projected by the Government. It is hoped that within the next two decades the smaller plants, covering all feasible urban areas, will be incorporated into the main national systems to provide efficient low-cost service.

SOUTH AFRICAN NEWS

From Our Cape Town Correspondent

SPEAKING at Kimberley recently, Mr. T. P. Stratten, a member of the Electricity Supply Commission, said that the building of another power station, possibly at Warrenton, had been carefully investigated. However, the high cost and the difficulty of moving coal from the north to such a station had decided the Commission against it and instead it was proposed to construct a 132 kV transmission line from the Rand system (Vierfontein) to the northern Cape area.

The time is not yet ripe for building atomic power stations in South Africa, according to the chairman of the Industrial Development Corporation, Dr. H. J. van Eck, who recently visited Britain as a member of a three-man mission on atomic energy. He said that South Africans did not realize what a great advantage their country had in the coal deposits, which enabled electricity to be sold more cheaply in the interior than it could be produced by atomic energy in Britain, and for about the same price at the coast as it was sold there. The size of the units being used in Britain was one of the difficulties in building atomic power stations in South Africa. "We should wait until smaller units are produced with relatively higher efficiency," he said. The processing and disposal of the highly radioactive and dangerous fission products were also important factors. If atomic power plants were started now in South Africa, it would either be necessary to build processing plants as well or else the uranium would have to be shipped to Britain for processing.

Because there has been an increase of 1s 8d a ton in the pithead price of coal, it is expected that electricity will cost more in the Western Cape, and perhaps also in certain other areas. The price of Transvaal and Orange Free State coal has been increased by 1s 8d a ton and that of duff by 2s 6d to 3s a ton. The pithead price of ordinary coal is between 9s and 9s 3d a ton, and duff costs 5s 6d.

The supply of electric power in the Union continues to increase impressively. The South African Reserve Bank's index for electricity generated reached a fresh peak of 189 (1948=100) in June, an increase of 13 per cent over the June, 1954, figure and of 27 per cent over June, 1953. For the first six months of this year the average at 174 is 14 per cent higher than last year and 14 per cent up on 1953. The strong upward trend in demand continues, especially in the Transvaal and Orange Free State, where the mining industry's appetite for power is growing rapidly as new mines come into production and the requirements of uranium plants increase. The industry has been operating on a power quota and has been obliged to take special measures to prevent inadequate power supplies from restricting output. Despite Escom's heavy capital expenditure programme it is likely to be some time yet before the mines can plan their operations against a background of ample supplies of power.

A new phosphate undertaking at Phalaborwa, in N.E. Transvaal, is entirely electrical in its operation, the power being supplied from a 2,500 kW power station erected on the property. There are 73 motors in the factory, with outputs ranging from 1 h.p. to 450 h.p. and aggregating 1,550 h.p. These motors have been manufactured to withstand arduous conditions in a semi-tropical climate.

Maximum Humidity

Its Effect on Engineering Design

FROM A CORRESPONDENT

AN incomplete understanding of the principles of specifying humidity tests for electronic and other equipment often results in uneconomic specifications. In many instances the limits provided are those used in aggravated testing and not those encountered in nature. For example, one aggravated test, which is valuable for ascertaining deterioration when properly controlled with natural deterioration, involves a relative humidity of 95 ± 5 per cent at 160 deg F. Such a condition results in a dew point of 156-160 deg F, but the highest dew point in nature does not exceed 90 deg F. Therefore an evaporator designed for operation with a 160 deg F dew point would have a cost many times higher than is actually needed.

The maximum humidities which should be considered by designers relative to the use of equipment in any part of the world are discussed by N. Sissenwine of the Air Force Cambridge Research Centre, Massachusetts, in a report which defines the meanings of absolute and relative humidity relative to dew point and vapour pressure, and makes simplified recommendations. A copy of this report has been received by the Technical Information and Documents Unit, Cunard Building, 15, Regent Street, London, S.W.1 (Ref. PB 113299).

Absolute humidity is defined as the weight of water per unit volume of space. It is generally specified in grains/ft^3, or grams/m^3. A number of other terms may be used to indicate the absolute humidity. For practical purposes they each have a "one to one" (single valued function) relationship with one another. The most important of them are dew point, the temperature at which condensation would take place if the air were cooled at a constant pressure, and vapour pressure, the portion of the atmospheric pressure which is due to its water vapour content.

Humidity and Equipment Design

The principal effect of absolute humidity on design concerns the operation of equipment which, whether incidental to its function or perhaps as its major function, condenses water vapour out of the air, or evaporates water into the air. An ordinary refrigerator does the former, detrimentally to its chief function, with the result that troublesome defrosting is required. Carburettor icing is another example and necessitates the provision of a special heater in aircraft for preventive purposes.

The amount of ice collected varies directly with the absolute humidity in either case. The refrigerator must be designed so that it can operate for a satisfactory period of time under the highest humidity expected before defrosting is required, while the carburettor heater must be able to melt the maximum amount of ice that may be expected during maximum power setting.

Absolute humidity has a slight effect on the operation of high voltage electrical equipment, because the flashover voltages required for air gaps will be increased when the humidity is high. In the most humid areas of the world this increase amounts to about 10 per cent in excess of the voltage normally required at the absolute humidities which prevail in temperate climates in the summer. During extremely dry winter (or Arctic) conditions, the voltages required for flashover may be 20 per cent lower than for the temperate summer, but this air gap position is very rarely encountered. Flashover along the insulators of high voltage equipment, causing carbonization, is a very important problem associated with condensation.

Absolute humidity must also be considered when designing a device which must operate during or following a transfer from a cold to a warmer environment, since condensation or frost may result if the temperature of the device is lower than the dew point equivalent of the absolute humidity of the warm air. Conversely, an object which can trap air may be similarly affected when moved suddenly into a cold environment, since the moisture contained in the air will condense when the temperature falls below the dew point and will freeze if this temperature is below freezing.

Determining Maximum Absolute Humidity

The amount of water vapour that the air can hold (in other words, the maximum absolute humidity possible) roughly doubles for each 18 deg F. The source of this water vapour is extensive bodies of water, e.g. oceans, seas and large lakes. These bodies of water use the heat recovered from the sea to vaporize their surface water. The absolute humidity over the water is limited to that which corresponds to a dew point equal to the temperature of the surface water; that is to say, the dew point of the air above or near the water surface cannot naturally exceed the water surface temperature. In fact, because of upward diffusion, the dew point a few feet above water is invariably a few degrees lower than the water temperature.

To determine the maximum absolute humidity which might ever be encountered, it is only necessary to examine world maps of the sea surface isotherms. It will be found that the hottest body of water is the Persian Gulf, with an August mean temperature exceeding 90 deg F.

Due to condensation and diffusion, absolute humidity decreases with horizontal and vertical distance of the air mass from the source of water. It is also limited at higher altitudes by the cooler temperatures, which will not support large amounts of vapour. Even in clouds the absolute humidity will be far lower than is possible at the surface. It will correspond to the temperature of the water droplets or ice particles in the cloud. For the very warm levels of the atmosphere, which are at 140,000 to 200,000ft and above 400,000ft, there is no water source and the total pressure of the air, which includes that of the water vapour, is far less than the vapour pressure at even low absolute humidity near the surface.

Though no direct measurements of humidity above 100,000ft are available, it may be concluded that high absolute humidity aloft need not be considered a design problem if the equipment is designed to operate at the absolute humidities probable at the surface. In the case of electronic equipment the low air density at high altitudes presents a far more critical problem, because flashover voltages are reduced to as low as 300 V even for large gap distances.

The maximum absolute humidity recorded (dew point 88 deg F) is only slightly greater than the maximum that could be expected in a temperate zone such as the United States.

It is concluded that a dew point of 85 deg F, corresponding to an absolute humidity of 13 grains/ft^3 appears to be a reasonable criterion to adopt when designing equipment whose operations are sensitive to high absolute humidity.

Relative humidity is the ratio of the amount of water vapour in a volume of air to the amount that the air could hold at its temperature. It can be calculated by the ratio of the corresponding absolute humidities or vapour pressures and is an indication of the degree of saturation.

The chief design problem caused by relative humidity is degradation. Micro-organisms are active even at 40 deg F when the relative humidity exceeds 80 per cent. They will remain active at 80 deg F even with a relative humidity as low as 40 per cent. They thrive at 80-90 deg F with humidities of 80-100 per cent.

High relative humidities also cause many organic materials to swell and lose shape. Degreased human hairs, for example, lengthen with increasing relative humidity and are used in hygrometers for this reason.

Corrosion of metals and etching of ceramics are important effects which increase when the relative humidity exceeds 30 per cent and the temperature approaches 80-90 deg F.

Deterioration due to high relative humidity is generally a storage problem, but designers have also to contend with the operational problem presented by high voltage breakdown and leakage along insulators, which faces motor car owners in humid weather and is equally annoying to operators of electronic equipment. This trouble arises when the relative humidity reaches 100 per cent with consequent condensation on and short circuits of the electrical components due to increased surface conductivity. Sometimes it occurs at relative humidities of slightly less than 100 per cent, because of the collection of water by hygroscopic dust and dirt on these electrical parts.

The maximum relative humidity possible, namely, 100 per cent, is encountered in nature over a sufficiently large part of the world and at vertical depths of the atmosphere frequently enough to be considered in the design of any equipment that may operate outdoors. A humidity of 100 per cent is observed in fog and in clouds.

A relative humidity of 100 per cent is approached very closely in a steaming hot jungle, where the degradation effect is generally at its worst because of the effect of high temperature. In the dry Arctic winter high relative humidity is the rule rather than the exception, since the loss of heat by radiation during the long nights causes the temperature to drop to the dew point of the air and then gradually depresses this dew point as the water vapour sublimates into frost or ice fog. Fortunately, very low temperatures bring the activity of micro-organisms and the chemical reactions of corrosion to a standstill and the amount of water vapour available for sublimation is extremely small.

Since its effects are generally long-term, relative humidity is a problem associated mainly with stand-by storage, where it has a diurnal variation. Designers should therefore take into consideration the daily cycle of relative humidity in the jungle, where degradation is known to be at its worst.

Conclusions

In the light of these brief observations the following recommendations can be made:—

(*a*) When considering the effect of high humidity on the design of equipment, the designer should segregate the problem into operation and stand-by storage. If the operation of the equipment is affected by high humidity, absolute humidity should be considered. Degradation of most equipment is sensitive to high relative humidity. High voltage breakdown, an operational problem, is sensitive to both relative and absolute humidity.

(*b*) The highest absolute humidity which need be considered in operations is 13 gr/ft^3 (dew point 85 deg F or a vapour pressure of 1·201in of mercury).

(*c*) The highest relative humidity which need be considered, chiefly in degradation, is 100 per cent, which will also cause an operational problem in the case of high voltage circuits. It can occur at temperature conditions ranging from the coldest Arctic temperatures up to 80 deg F and in clouds at the levels indicated. Since degradation is a long-term effect, which is greatest at high temperatures, operation should be possible after exposure to the diurnal cycle of relative humidity likely to be encountered in the tropical jungle. This can be approximated by subjecting components to 95 ± 2 per cent relative humidity at 80-85 deg F for 20 hours, followed by 4 hours of 100 per cent relative humidity with condensation at 75-80 deg F (air movement and radiation exchange negligible).

Steam Temperature Measurements

POSSIBLE errors in the measurement of steam temperatures in power stations were considered in a paper presented on 14th December by Messrs. D. H. Lucas and M. E. Peplow (Central Electricity Authority) before the Institution of Electrical Engineers' Supply Section. The importance of the subject, the authors pointed out, lay in its relationship to the maintenance of efficiency in turbines and to the need to protect pipes from overheating at the increasingly high steam temperatures adopted in electric power stations.

Errors might occur because of incomplete mixing of steam from different sources; temperature variations over the cross-section of a steam pipe; temperature differences between steam and thermometer pocket and between pocket and thermometer; slow response of thermometer; or inaccuracy of measuring instruments. These factors were worked out theoretically at Leatherhead Research Laboratories to cover a range of normal conditions and were confirmed by practical tests at Deptford West power station.

Steam conditions at that station were 400 lb/sq in and 775 deg F. The steam pipe had an internal diameter of 13in and an area of 0·92 sq ft and was lagged with 3in of magnesia plastic. Steam flow rate was 140×10^3 lb/hr and mass flow rate 152×10^3 lb/sq ft/hr. Steam with specific gravity of 0·0095 had a velocity of 65ft/sec. As far as possible means of adjusting results to other conditions were given.

Two streams of steam of normal turbulence entering a single pipe became thoroughly mixed in a distance of about 30 diameters. Temperature gradients in high-velocity steam in the well-lagged pipe at Deptford were found to be negligible except near the pipe wall; for higher or lower heat flows, temperature differences would be proportionate to the heat flow and for completely unlagged pipes they would be 20 to 30 times greater. Errors due to thermometer pockets were inappreciable except those resulting from time lag; the minimum depth of insertion of a ¼in thermometer was 4in and 3in when using an asbestos plug. Thermometers immersed in the steam could be very accurate, but the additional difficulty and risk introduced would not be justified under normal working conditions.

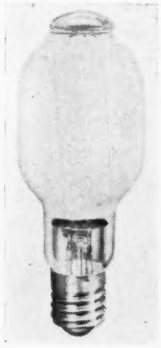
NEW ELECTRICAL EQUIPMENT

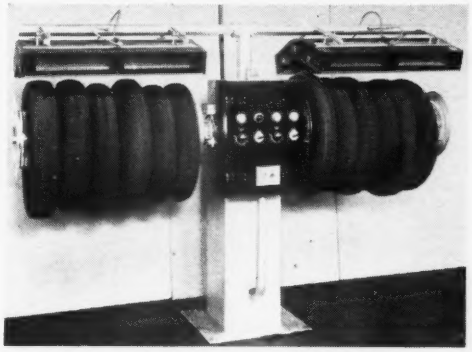
Colour Corrected Lamp

It is announced by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2, that on 1st January next their range of "Osram" colour corrected mercury fluorescent lamps will be extended by the introduction of a lamp rated at 250 W.

Similar in appearance to the 400 W lamp of this class introduced in November, 1954, it shares the same advantages of good colour rendering, high efficiency and universal burning position. It may be operated in conjunction with standard 250 W control gear and in the majority of installations will be fully interchangeable with the 250 W MA/V lamp. Magnetic deflectors are not required. Average light output throughout life is 9,250 lumens which is nearly 20 per cent higher than the figure for the existing 250 W MA/V lamp.

It will have a wide range of uses for street lighting and, because of its colour rendering qualities, will also be suitable for interior lighting in factories and similar installations. The list price will be £6.

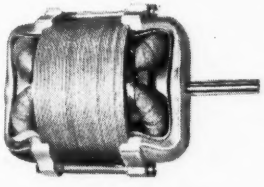




Left: G.E.C. 250 W colour corrected lamp. Right: Tyre drying machine

Miniature Motor

The type 10 WO squirrel cage electric motor, available from JONES & STEVENS, LTD., Long Lane, Littlemore, Oxford, is particularly suitable wherever a precision built miniature servo motor for any kind of drive or movement is required.



Jones and Stevens type 10 WO miniature motor

It has a nominal speed of 2,700 r.p.m. and is rated at approximately $\frac{1}{70}$ h.p. Overall measurements are only 2in by 3in, with a $\frac{3}{4}$in long ground shaft mounted in sintered bearings. The complete weight is no more than 8 oz. It is a single-phase a.c. motor and can be coupled to any of two voltages. The terminal connections are outside the motor housing, thus permitting an easy changeover. Normal voltage is 240/120, 50 c/s, but any range of voltages and frequencies can be provided for. The price of a single motor is £2 14s 6d. Prices for larger quantities are available on request.

Infra-Red Tyre Dryer

An infra-red tyre dryer has been developed by the GRANTHAM ELECTRICAL ENGINEERING CO., LTD., 6, Wharf Road, Grantham, with the co-operation of the Vacu-Lug Traction Tyre Co., Ltd., at Grantham, the purpose of the machine being to extract moisture from prepared tyres before remoulding.

In addition to the overhead infra-red projector heaters, under which the tyres are rotated, internal heaters are fitted. The heaters are controlled individually by energy regulators giving accurate temperature control. The model illustrated has a capacity of 12 average size tyres in each loading and the time taken for drying these tyres suitable for full bead to bead remoulding is $1\frac{1}{2}$ hours at 145-150 deg F.

White Noise Generator

A type 419 white noise generator has been designed by DAWE INSTRUMENTS, LTD., 99, Uxbridge Road, London, W.5, to produce electrical noise uniform in intensity over the entire audio and video frequency bands. Three bandwidth ranges are provided, covering 30 c/s to 20 kc/s, 30 c/s to 500 kc/s, and 30 c/s to 5 Mc/s, respectively. The first of these bands covers adequately the whole audio frequency spectrum and can be used for testing the acoustical properties of rooms, the frequency response of audio amplifiers, and for studio, loudspeaker and microphone tests. The 500 kc/s and 5 Mc/s bands can be used for filter tests and cross-talk investigations on multi-channel carrier telephony equipment.

Dawe white noise generator

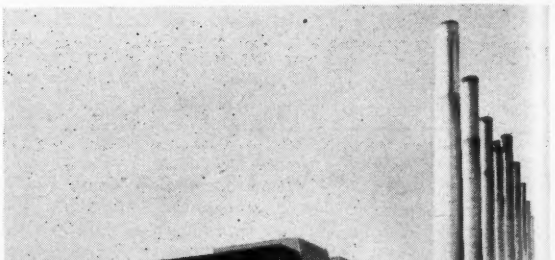
The noise source in the instrument is a thyratron valve placed in a transverse magnetic field. The magnetic field damps the oscillations which are usually produced by a gas discharge and largely equalizes the energy level of the noise spectrum.

The spectrum is further modified by the two-stage wide-band amplifier which has three different filter networks between the first and the second stages. In the 20 kc/s and 500 kc/s ranges low-pass filters are switched in and these give a gradual cut-off for frequencies above the nominal band. In the 5 Mc/s range the network compensates for the peak in the noise output of the thyratron at 700 kc/s, the fall in level at the higher frequencies thus providing a uniform noise spectrum up to 5 Mc/s. A thermal delay switch protects the thyratron when the instrument is first switched on. The instrument is self-contained, mains operated, and portable.

Industrial Engine Agreement

At a Press reception held in London last week, Lord Tedder, chairman of the Standard Motor Co., announced the signing of an agreement with Auto Diesels, Ltd., whereby Standard engines are to be adapted for industrial purposes (including generating sets) by Auto Diesels and marketed exclusively by them throughout the world. The new range is registered under the name of "Stad" and will be available for operation on petrol/gasolene, paraffin/TVO, diesel/gas oil and natural gas. Basically the engines will be the same as those fitted in the range of Standard cars and Ferguson tractors; they will be taken from the normal assembly lines at Coventry, engineered by Auto Diesels and distributed by them from their Uxbridge works.

GENERATION AND DEVELOPMENT



This new 1,600 MW steam station of the Tennessee Valley Authority, at Kingston, Tennessee, has recently been completed with the installation of the ninth unit. The illustration is of interest in showing the difference between British and American power station design

Output in November

The Ministry of Fuel and Power's monthly return shows that 7,589 million kWh was generated in November. This was 8·7 per cent more than a year ago, a rate which fell below the average for the year. Weather conditions last month were, however, milder than in November, 1954, when there was an increase in output of 14·5 per cent.

At 30th November the total installed capacity in stations of the Central Electricity Authority, the South of Scotland Electricity Board and the North of Scotland Hydro-Electric Board was 21,795 MW, compared with 21,600 MW a month before. This increase of 195 MW brought the net increase in capacity since the beginning of the year to 1,228 MW, compared with the figure of 1,398 MW for the whole of 1954. Plant newly commissioned last month in C.E.A. power stations included 60 MW sets at Meaford "B" (B.T.H.), Uskmouth "A" (G.E.C.) and Stella North (C. A. Parsons), 550,000 lb/hr boilers at Marchwood (John Thompson), Keadby (Stirling), Stella South (Clarke Chapman) and Ince (International Combustion), a 515,000 lb/hr International Combustion boiler at Drakelow "A" and a 320,000 lb/hr Babcock & Wilcox boiler at Brighton "B."

At 3rd December coal stocks at power stations aggregated 7·1 million tons (equal to 6·9 weeks' supply), which compares with 5·8 million tons (6 weeks' supply) a year ago.

New Welsh Power Station

When a £150,000 road improvement scheme at Barry was under discussion at the December meeting of the Glamorgan Roads and Bridges Committee the Mayor of Barry said that the project was urgent because work on the new generating station at The Leys was due to start in January.

Tyneside and Bristol Supply Failures

Electricity supplies to some 400,000 consumers in the North East were interrupted last week as the result of a switchgear fault at Stella South power station. The breakdown occurred at 8·30 a.m. on 14th December and the supply was not fully restored until teatime. Electric trains and trolley-buses came to a standstill, shipyards were put out of action and colliery winding gear was stopped.

The North Eastern Division of the Central Electricity Authority and the North Eastern Electricity Board, in a joint statement, said that the switch breakdown caused a fault on the 132 kV power station busbars. This disconnected the local Tyneside distribution system from the 132 kV national grid, resulting in the overloading of Dunston, Carville and South Shields power stations to such an extent that it was necessary to disconnect these stations from the local distribution system.

Shortly after mid-day on 15th December an explosion occurred at the Lockleaze (Bristol) substation of the South Western Electricity Board which caused an interruption of the electricity supply to the central and northern areas of the city lasting for over an hour. A technician at the station, Mr. J. Crompton, was taken to hospital with severe burns, and an engineer, Mr. R. Street, was also injured.

Stratford Change-over

Speaking at an exhibition of electrical equipment at Stratford-upon-Avon, the deputy chairman of the Midlands Electricity Board announced that the d.c. to a.c. change-over in the centre of Stratford would be completed in March. The scheme, costing £63,000, was begun in 1953 and will affect 1,200 consumers. Two reinforcements are also in progress, one to provide alternative supplies to the east side of the river and the other to the Stratford industrial area.

Services in Fife Houses

Fife County Council's present practice is to equip half of its houses with gas cookers and boilers. The Housing Committee, however, is now to consider whether or not this arrangement should cease. At a meeting of the Committee it was stated that service charges had to be paid to supply gas and electricity to the houses and there would be a saving if only one service were installed. Mr. A. Eadie, who presided, said they would want to know the relative costs of gas and electricity before deciding and it was agreed that these figures should be obtained. Mr. G. Sharp observed that electricity was cheaper than gas, but special utensils were needed. Maintenance of electric cookers in 1953-54 had cost £3,460 while gas cookers in the same year had cost only £53.

Roxburgh Hydro-Electric Scheme

The big hydro-electric scheme at Roxburgh, New Zealand, originally scheduled to come into operation this year, has not yet been completed, but progress has been speeded up in the last year or so and the contractors,

ELECTRICITY GENERATED AND PLANT INSTALLED

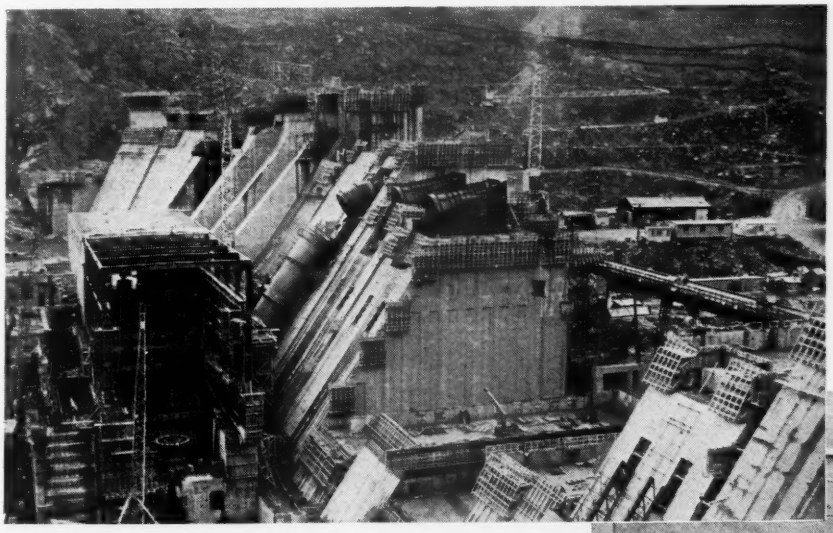
	Fuel consumed Thousand tons			kWh generated Millions			kWh sent out Millions	Installed capacity (m.c.r.) MW
	Coal	Coke and Breeze	Oil	Steam	Water power	Total		
Central Electricity Authority ...	3,657	71	16·1	6,949	7	6,967	6,546	19,919
N. of Scotland H.E.B.	33	—	1·5	51	60	118	115	624
S. of Scotland E.B.	259	6	0·2	485	20	504	479	1,252
Total for November, 1955 ...	3,949	77	17·8	7,485	87	7,589*	7,140	21,795
Corres. total for November, 1954	3,695	97	20·6	6,749	222	6,984	6,583	20,015
Inc. or dec. as a percentage of 1954	+6·9	−20·6	−13·6	+10·9	−60·8	+8·7	+8·5	+8·9
Total to date (11 months), 1955	37,692	934	1,943	70,913	990	72,053	67,709	
Total for corres. 11 months of 1954	34,712	1,006	1,499	63,946	1,466	65,541	61,632	
Inc. or dec. as a percentage of 1954	+8·6	−7·2	+29·6	+10·9	−32·5	+9·9	+9·9	

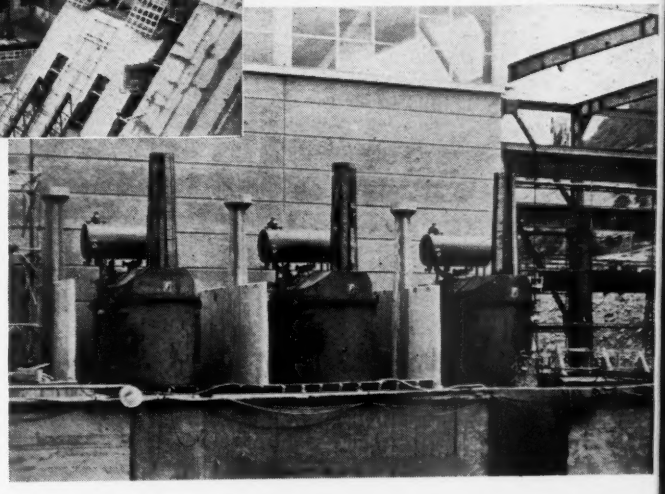
* The total figure includes generation by other methods amounting to 17 million kWh.

Cubitts, Zschokke & Downer, are now six months ahead of the revised schedule laid down for the contract by the State Hydro-Electric Department.

Ultimately the station will contain eight 44,444 kVA, 136 r.p.m. vertical water-wheel alternators, the first four of which have been ordered from the British Thomson-Houston Co., Ltd. One is now on site in process of erection and the first bank of generator transformers is also installed ready for connection. The alternators are designed to generate at 11 kV and Ferranti single-phase transformers of 15 MVA rating, 11/127 kV, will be star-connected to step the voltage up to 220 kV for transmission. The alternators will be driven by Francis turbines manufactured by the Dominion Engineering Co., Montreal, Canada. One of these is already installed, the scroll case for the second is nearing completion and the runner for the third turbine is installed. This can be clearly seen in the accompanying photograph in which the partially completed power house is on the left (downstream) side of the dam.

The contractors now anticipate being able to complete the dam and power-house to a sufficient extent for the State Hydro-Electric Department to be able to operate the first two generators by the end of 1956. The final installed capacity of 320 MW will make this by far the largest single generating station in New Zealand and it is hoped to build up to this capacity by installing the remaining four generators in the early 1960s.





A recent view showing the progress of work on the Roxburgh hydro-electric development, the largest in New Zealand, and (right) Ferranti single-phase 11/127 kV generator transformers on power station platform

Indian Legislation

The provisions of the Electricity Supply Amendment Bill, now before the Indian Parliament, were commented upon by Mr. K. G. Milne, chairman, at the eleventh annual general meeting of the Federation of Electricity Undertakings of India held last month in Calcutta. He said that the industry had long sought to obtain a return on investment sufficiently attractive to enable capital to be raised for development. The Bill provided for an increase of ½ per cent based on the present bank rate, but other industries competing in the money market were able to earn much higher returns and he could not see why the 2½ per cent margin over the bank rate that the electricity supply industry had asked for should be regarded as unreasonable. The industry also felt that the rejection of its request for the inclusion of provisions for a reserve to meet deferred taxation liability was disappointing, as also were the ungenerous terms hedging the proposals for a new development charge.

By next March it was expected that the remainder of the States would have constituted Electricity Boards, and the Bill proposed to vest in the State Governments greater powers for the control and supervision of these Boards. Mr. Milne said it was difficult at this stage to assess the effect of the amendments on the working of the Boards, but the tendency must be to dampen their initiative, which he felt to be most regrettable.

Tax on Electricity

In its 1954-55 report the Federation of Electricity Undertakings of India refers to recommendations of the Taxation Inquiry Commission. The Federation says that the Commission, brushing aside the electricity supply industry's fundamental objection to the levying of electricity duty by State Governments and taking it for granted that there is little opposition to a tax on electricity used for lighting and fans, has confined its arguments to the effect on production costs. Noting that power costs hardly exceeded 2 per cent of the total cost of manufacture, the Commission said it was difficult to agree that the levying of a duty on industrial consumption was unjustifiable. It therefore recommended the extension of the duty to include industrial supplies.

The Federation's report adds that it has since been stated that the State Governments may be asked by the Central Government to divert receipts from electricity duties towards subsidizing rural electrification.

Laxapana Scheme

Our Colombo correspondent states that copies of the report on Stage 2B of the Aberdeen-Laxapana hydro-electric scheme made by the Government's consulting engineers, Messrs. Preece, Cardew & Rider, have been flown to engineering firms in France, Japan, the United States, the United Kingdom, Germany and Italy. Copies have also been made available to local firms. They have been told that the Ceylon Ministry will examine any alternative schemes with constructing firms who are interested in undertaking the project.

In the opinion of Mr. J. S. Parkes, Adviser on Electrical Engineering to the Government, the Southern Province of Ceylon will not get its bulk supply by 1960 as originally planned unless arrangements are made immediately to carry out this stage of the Laxapana hydro-electric scheme. The project, he says, is likely to commend itself on its own merits to the International Bank for Reconstruction and Development. He

estimates the cost at Rs.14 million. The electrification of the Southern Province, Mr. Parkes states, would require a double circuit 132 kV transmission line from Laxapana to the load centre and he recommends the immediate sanctioning of this line.

Mr. Rosslyn Koch, M.P., has been appointed chairman of a special committee to investigate the causes of the recent generator failure at Laxapana. The other members of the committee are Mr. G. D. Somasuntheram (Department of Electrical Engineering, University of Ceylon) and Mr. E. C. Wijesekera (Director of Development, Ministry of Transport). Mr. I. Siriwardene (Department of Electrical Undertakings) will act as secretary. The committee has been appointed by the Minister of Transport, Mr. Montague Jayawickreme. The main terms of reference are to investigate the cause of failure of the runners of the generating plant; to investigate the damage to the stator coils; and to examine the condition of the tunnel at Norton Bridge.

Street Lighting Schemes

OSSETT (Yorks) Town Council has applied for loan sanction for electric street lighting schemes to replace gas in the Wakefield-Dewsbury road (£5,340); The Green and Horbury Road (£1,500); and Intake Lane.

SUNDERLAND Town Council has received loan sanction for £14,858 for street lighting on the Grindon Village and Farringdon housing estates.

CLOMER U.D.C. is seeking permission to borrow £13,600 for improving the lighting of Class A roads.

The borough engineer of MIDDLESBROUGH has prepared a £10,000 scheme for street lighting on the Pallister Park housing estate.

REDCAR Town Council is to spend £16,000 on electric street lighting improvements.

L.E.B. Training Centre

"OPEN DAY" AND PRESENTATION OF AWARDS

THURSDAY last week was the first "open day" of the London Electricity Board's training centre for craft apprentices at Hutton Street, Dorset Rise, E.C.4, and the opportunity was taken to present to a number of apprentices and other employees of the Board non-monetary awards ranging in value from £2 10s to £7 for their achievements in the past year.

Dr. P. Dunsheath, C.B.E., who presented the awards, said that the Board was starting something new at the centre the results of which would go on into the next century. This was only the beginning and in his opinion in a few years' time the available space would be inadequate.

Mr. L. H. Welch (chief engineer, L.E.B.), who is also chairman of the London Branch Ambulance Committee, presented about thirty apprentices with St. John Ambulance certificates. Mr. D. B. Irving (deputy chairman, L.E.B.) was in the chair.

The original idea for a centralized training centre owes much to the inspiration of Mr. J. F. Middleton, the Board's education and training officer, and the project was approved by the L.E.B. in April, 1953. It was not until the beginning of this year, however, that the first group of sixteen apprentices commenced training there; previously such trainees were required to spend their entire five-year course in their local sub-area workshops. Now each boy spends eight months at the centre, the time being devoted to learning essential machine and fitting shop practice. As each group completes its course it is replaced at four-monthly intervals by a fresh intake. Thus every year the centre will turn out 48 trained apprentices.

The centre, which is situated on two floors of the old meter testing department above Dorset Rise substation, is well-equipped with up-to-date machines and appliances. On the workshop floor are six screw-cutting lathes, two shaping machines, a 1½in pillar drill, two offhand grinders, an engraving machine, a surface grinder and a tool and cutter grinder, six ½in pillar drills, and a horizontal drilling machine; there is also a forge, a brazing hearth and plants for both oxy-acetylene and electric arc welding. On the floor above the workshop are a reading room, two small lecture rooms and a large lecture hall. The hall is equipped with a 16 mm film projector and screen.

The boys work a 44-hour week and are paid apprentice rates according to the N.J.I.C. Agreement. There is a teaching staff of three under the supervision of Mr. J. G. Shilcock, A.M.I.Mech.E.

Dr. P. Dunsheath addressing the apprentices and employees of the Board after the presentation of the awards. On his left are Mr. D. B. Irving and Mr. H. S. Smith (personnel officer)

Section of the workshop at the L.E.B. Training Centre

Financial Section

STOCKS and SHARES

WITH the approach of Christmas, activity in Stock Exchange markets tended naturally to subside. To the seasonal distractions were added the anxiety over foreign affairs and an uncertain turn in Wall Street, the strength of which has hitherto been a consistently helpful influence over here. From all the signs, however, the industrial market looks like finishing the year in much better form than had seemed at all probable a couple of months earlier. Share prices have failed by some measure to re-scale the heights at which they stood in mid-summer, but have moved notably clear of the depressed Autumn Budget level. Markets are in sound condition to respond to better news from the economic and political fronts.

Fall and Recovery

The following table was produced here in the middle of October last to illustrate the size of the relapse at that time from the peak prices of July. The third column, added this time, shows the extent to which the lost ground has been regained by the middle of the present month.

Company	Mid-Month		
Ord. Share	July	Oct.	Dec.
A.E.I.	96/-	77/6	84/-
Auto. Tel.	74/-	62/6	69/6
Babcock & Wilcox ...	97/-	77/6	82/3
Brush	9/3	7/6	7/3
E. K. Cole	25/-	20/3	21/9
Cossor	13/3	9/3	9/6
Crompton Parkinson ...	19/-	15/6	15/-
Decca	45/6	36/3	43/6
E.M.I.	30/6	26/-	29/6
G.E.C.	76/6	60/-	63/-
I.C.I	56/3	46/3	47/6
Lancs. Dynamo	56/3	43/9	48/6
Lucas	55/-	43/9	39/-
Parsons	95/-	75/-	83/-
Plessey	87/6	66/3	82/6
Reyrolle	125/-	95/-	107/-
Westinghouse	108/9	86/-	97/6

Present Yields

While many considerations affect the investor's ideas about the sort of return he expects to obtain on his money at various times, there seems to be an attraction about a 5 per cent yield which satisfies him as being fair enough in most circumstances. This disposition may have played a part in stiffening the recent resistance of industrial ordinary shares to further decline at a point where the yield on many first-rate equities came, in fact, to around that mark. In the specially favoured sections of the electrical market, investors are still prepared to accept considerably less: in the case of A.E.I., English Electrics, Lucas and Plessey, for instance, the return from this year's dividends remains under 4 per cent; while Pye, Parsons and Reyrolles are among the shares on which the yield is still in the neighbourhood of $2\frac{1}{2}$ to 3 per cent.

Five Per Cent Upwards

Among the popular electrical equipment and allied shares on which the current yield comes now into the 5 to $5\frac{1}{4}$ per cent range or thereabouts, mention may be made of the ordinary stocks of W. H. Allen, Aron Meter, Crompton Parkinson, Electric Construction, Hackbridge and Hewittic (allowing for the scrip issue), Taylor Tunnicliff, Allen West, Chloride Electrical, Telegraph Condenser, Ever Ready, and Richardsons Westgarth. In the $5\frac{1}{4}$ to $6\frac{1}{4}$ per cent yield bracket may now be included such issues as Brush, Henley's, Scottish Cables, Johnson & Phillips and Southern Areas. R. A. Lister were marked up to 32s 6d c.d. after publication of the annual results, and show a $6\frac{1}{4}$ per cent yield on the 10 per cent dividend.

Lucas Meeting

From the chairman's speech at the annual meeting of Joseph Lucas (Industries) it appears that conditions in the motor industry, which continues to provide the group with its major source of profit, were a main factor in the decision to keep the dividend at $7\frac{1}{2}$ per cent. This is the equivalent of the previous year's rate, and, by market reckoning, involves the distribution of barely one-sixth of the net surplus available. After mentioning that Lucas are engaged in enlarging their manufacturing facilities in order to meet the additional demands created by the big expansion of the motor manufacturers, Mr. Waring deals with the somewhat confused situation created by the increase in purchase-tax on cars, and by the new restrictions imposed on imports into the markets of Australasia. In the balance-sheet the total of group reserves is shown to be approaching again the amount of the issued ordinary capital of £12½ million, despite the 100 per cent capitalization issue distributed eighteen months ago.

New Issues

Provisional allotment letters were due to go out on Wednesday of the past week to Cable & Wireless (Holding) stockholders, giving them the right to subscribe for one new £1 share at par for every £10 ordinary stock held. With the old shares at 43s 3d the value of the rights comes to a little over 2s per share; and, on the basis of the 10 per cent dividend paid on the existing capital, the prospective yield on the shares in their "ex-rights" form is between $4\frac{3}{4}$ and 5 per cent. The new Pye "A" deferred shares have been dealt in at a premium of about 9s 3d on the price of 12s 6d at which they are offered to the company's shareholders. The call for the whole purchase price is due to be paid by 29th December. The chairman of S. Smith & Sons mentioned at the annual meeting that it may become necessary to raise fresh capital.

E.M.I.

Mr. J. F. Lockwood had under review, at the recent annual meeting of Electric & Musical Industries, a year during which increased efficiency, and a rise of 22 per cent to £40 million in turnover, was reflected in increases of a million to nearly £2 million in the group profit, and of £286,000 to £832,000 in the net surplus after tax. The last figure covers more than twice the ordinary distribution of 15 per cent, which is being raised from 10 per cent. Regarding the further outlook, the chairman calls attention to the fact that the group will have the benefit next time of a full year's trading profit from the major interest acquired during 1955 in Capitol Records, of America, at a cost of about £3 million. He is concerned about the effect on business of the changes in purchase-tax and hire-purchase restrictions, and of future wage increases, but looks forward with confidence. The company's 10s shares have been quoted recently at a little under 30s.

K.G. Holdings

Having risen in very active dealings during the course of November from 1s 9d to practically 8s at one time, the 1s shares of K.G. Holdings have settled back to nearer 7s since the annual meeting. The price is evidently related more to future prospects of the enterprise than to the present level of earnings, which amounted to £15,000 net in the last financial year, or to the 12½ per cent dividend paid for that period on capital of £82,000. It may be recalled that this company sold its original rubber growing interests and invested the proceeds in a group of electrical and mechanical engineering enterprises. A further acquisition, purchased by means of an issue of shares, has now been announced by the chairman.

Factory Equipment Exhibition

Mr. Peter Thorneycroft, President of the Board of Trade, will open the 1956 Factory Equipment Exhibition which is being held at Earls Court from 9th to 14th April next. The exhibition is the fourth of its kind and the largest of the series so far. It will cover factory construction, equipment and maintenance, the handling, storage and packing of goods, engineering products, equipment and services for the welfare and safety of operatives, drawing and works office equipment and supplies. Productivity will be the keynote and the British Productivity Council is holding a three-day conference during the exhibition. Another special feature will be a large composite display illustrating the use of oil fuel in industry.

REPORTS and DIVIDENDS

Telephone Rentals, Ltd., has declared an interim dividend of 5 per cent (against 4 per cent). It is emphasized that the increased interim dividend does not presage an increased total dividend for the year, but is merely the fulfilment of the proposal made by the chairman to the shareholders in June last concerning the maintenance of the proportionate payments as between the interim and final dividends.

R. A. Lister & Co., Ltd.—Subject to final audit, the group profit for the year to 30th September last is £998,250, as compared with £859,019 for the preceding year. Taxation absorbs £526,029 and the net profit attributable to members of R. A. Lister is £503,258, of which £172,520 is in respect of profits retained by subsidiary companies. It is proposed to pay a final dividend of 7½ per cent, again making 10 per cent for the year.

Tube Investments, Ltd. — Agreement has been reached, subject to the completion of formalities, for the acquisition by Tube Investments, Ltd., of the whole of the issued share capital of the Power Centre Co., Ltd. This company, with works at Wednesbury and Walsall, manufactures industrial electrical distribution gear consisting of overhead busbar systems, ironclad switchgear and switchboards, cable trunking and accessories. As is the usual Tube Investments' practice, the separate identity of the Power Centre Co. will be preserved.

Ferranti, Ltd.—At an extraordinary meeting held in London on 15th December, the resolution dealing with borrowing powers and the consequent alteration to the articles of association was carried.

Enfield Rolling Mills, Ltd.—If an offer to purchase the capital of a private company is accepted, the company will make a rights issue of 130,000 £1 ordinary shares at 62s a share on the basis of one for every 12 held. The new ordinary shares will rank for the final dividend in respect of the year to 31st December next.

E. N. Bray, Ltd.—It is announced that the United Molasses Co., Ltd., has purchased 96 per cent of the ordinary and preference shares of E. N. Bray, Ltd. The purchase cost involves approximately £200,000.

Pinchin, Johnson & Associates, Ltd., has declared an interim dividend of 5 per cent (against 7½ per cent) on increased capital.

Scottish Cables, Ltd., has declared an interim ordinary dividend of 7½ per cent (unchanged).

New Companies

Plessey Research, Ltd.—Registered 7th December. Capital £1,000. Subscribers: Winifred J. Pearmain and Dorothy B. Harvey. Secretary and solicitor; J. S. Davison, Ilford. Regd. office: 56, Vicar Lane, Ilford, Essex. (See *Electrical Review*, 16th December, page 1172.)

J. W. Davis (Plymouth), Ltd.—Registered 29th November. Capital £8,000. Radio, electrical and television engineers and dealers in electrical apparatus, etc. Directors: J. W. Davis and N. J. Davis. Regd. office: Rendle Street, Plymouth, Devon.

Cresta Electronics, Ltd.—Registered 23rd November. Capital £1,000. Manufacturers of and dealers in radio, television and electronic equipment, etc. Directors: C. N. Stuart, A. S. Harrington and S. Goldsmith. Regd. office: The Parade, Deepcut Bridge Road, Blackdown, Hants.

Specialised Components (Yorkshire), Ltd.—Registered 11th November. Capital £10,000. To acquire the business of the sale and distribution of car batteries, brake linings, clutch facings, fan belts, ignition components, cables, auto and electrical engineers, etc., carried on by W. W. Lowsley and N. Cooper at Hull, Westmoreland Avenue, Bridlington, and at Mill Yard, Victoria Road, Scarborough, Yorks, etc. Directors: W. W. Lowsley and N. Cooper. Regd. office: 279, Anlaby Road, Hull.

Whitehouse Engineering Co., Ltd.—Registered 11th November. Capital £1,000. To acquire the goodwill of the business of J. Whitehouse carried on at 3, Allerton Street, Cardiff, as Whitehouse Engineering Co., and to carry on the business of electricians, electrical contractors, electrical, mechanical, television and radio engineers, etc. Directors: J. Whitehouse and J. W. Fleming. Regd. office: 3, Allerton Street, Cardiff.

Kindler Electric Co., Ltd.—Registered 28th October. Capital £1,500. Manufacturers, importers and exporters of and dealers in electrical, wireless, telephone and telegraph apparatus and accessories, etc. Directors: Mrs. Dora G. M. Jones and J. P. Jones. Solicitors: Durnford & Gale, Windsor.

Motolec (Devon), Ltd.—Registered 28th October. Capital £500. Electrical engineers and contractors, manufacturers of and dealers in electric motors, etc. The first directors are to be appointed by the subscribers. Regd. office: 9, Market Street, Newton Abbot.

Aconticlox Electric, Ltd.—Registered 1st November. Capital £1,000. Manufacturers of clocks, watches, chronometers, etc. Directors: R. Walters and H. Bryant. Regd. office: 17, Surrey Street, Strand, W.C.2.

W. H. Smith & Partners, Ltd.—Registered 2nd November. Capital £10,000. Manufacturers of and dealers in dynamos, motors, armatures, etc. Directors: W. H. Smith and Mrs. Kathleen M. Smith. Regd. office: 14, Broadway Market, Ilford, Essex.

Silver & Leigh, Ltd.—Registered 19th October. Capital £500. Manufacturers of and dealers in electrical apparatus and equipment, radio and television apparatus, etc. Directors: A. Silver, G. Leigh, J. Silver and H. Levy. Solicitors: B. L. Harris & Co., 24, Bedford Row, W.C.1.

Television & Electronics Patrol, Ltd.—Registered 24th October. Capital £500. Maintenance and repair of radio and television sets, etc. Directors: E. S. Parsons and H. de Souza Gilman. Regd. office: 8, Western Road, Romford, Essex.

Commercial Television Conversions, Ltd.—Registered 22nd September. Capital £100. Manufacturers, distributors and assemblers of television convertors and accessories, etc. Directors: W. J. T. Pingfram and D. A. Rose. Regd. office: 14, Robert Adam Street, W.1.

Increases of Capital

Giles (Electrical Engineers), Ltd.—Increased by £7,000, in £1 ordinary shares, beyond the registered capital of £1,500.

Telecommunication Instruments, Ltd.—Increased by £2,000, in £1 ordinary shares, beyond the registered capital of £4,000.

Neosid, Ltd.—Increased by £18,000, in £1 5 per cent non-cumulative "B" preference shares, beyond the registered capital of £20,000.

T. Clarke & Co., Ltd.—Increased by £150,000, in 2s ordinary shares, beyond the registered capital of £100,000.

W. J. Furse & Co. (Manchester), Ltd.—Increased by £20,000, in £1 ordinary shares, beyond the registered capital of £10,000.

Fractional H.P. Motors, Ltd.—Increased by £8,000, in £1 6½ per cent redeemable preference shares, beyond the registered capital of £40,005.

Liquidation

William Gartside, Ltd., electrical engineers and contractors.—Winding up voluntarily. Liquidator, Mr. H. Whitehead, 1-4, Clarence Arcade Chambers, Ashton - under - Lyne, appointed 24th November.

Bankruptcies

B. T. Smith, The Studio, Ramsgate, Louth, Lincs, electrical engineer and contractor.—Trustee, Mr. L. F. McCulloch, 26, South St. Mary's Gate, Grimsby, released 9th November.

D. J. Hartshorne, 778, New Hey Road, Huddersfield, and Brook Royd Mills, Stainland, near Halifax, trading as Boyce, Weir & Co., electrical and mechanical engineers.—Last day for receiving proofs for dividend 28th December. Trustee, Mr. N. Smith, 12, Market Street, Hebden Bridge, Yorks.

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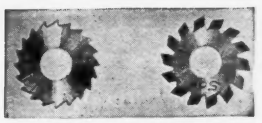
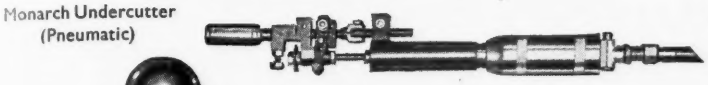
Quick, clean "U" or "V" undercutting of almost any size or type of commutator can be effected with the aid of power milling tools as illustrated.

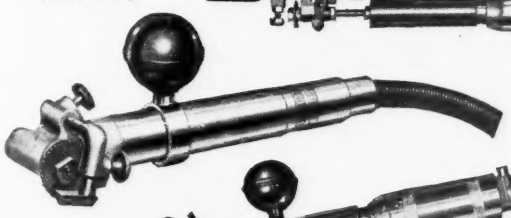


Undercutting Saw — Undercutting "V" Cutter

Monarch Undercutter (Flex-Drive)



Monarch Undercutter (Pneumatic)

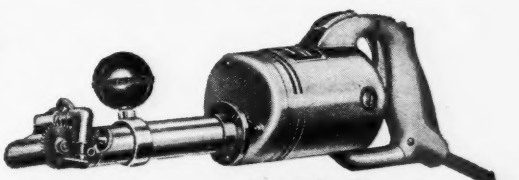


Mica Miller (Flex-Drive)

Mica Miller (Pneumatic)

With small saws or "V" cutters slots can be cut almost to the risers and only in special cases is it necessary to complete the cuts by file.

The milling heads are interchangeable with the oscillating heads of the Mica Slotters used in the Martindale System No. 1.



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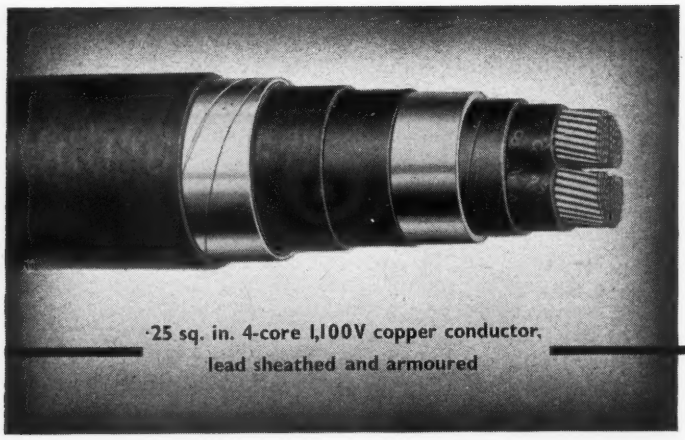

·25 sq. in. 4-core 1,100V copper conductor, lead sheathed and armoured

THIS 1,100 V. DISTRIBUTION CABLE CARRIES 395 AMPS. AND COSTS APPROXIMATELY

£3,500 PER 1,000 YARDS

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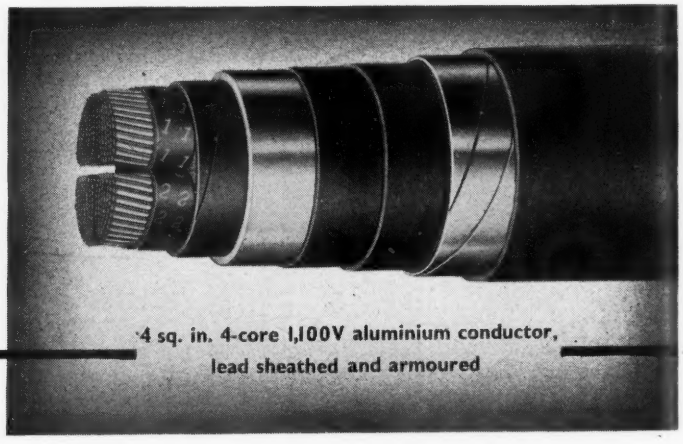

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THE SAVING IS EVEN GREATER if you use an ALUMINIUM SHEATH with an ALUMINIUM CONDUCTOR

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ELECTRICAL ENGINEERS AND CABLE MAKERS

Canadian Electrical Trade

Opposite Trends of Imports and Exports

DURING the first half of this year the total value of Canadian imports of electrical goods was $104 million, an increase of $10 million as compared with January-June, 1954. Radio apparatus was the most important item and also showed the biggest increase; the United Kingdom maintained her share in this trade and in some other lines but not in vacuum cleaners and washing machines. There were larger imports of dynamos, generators and most motors. In the increased business in lamps, Japan made headway. Decreases took place in refrigerators, storage batteries, switchgear, controllers and starters. (Canadian $2·8 = £1.)

In Canada's exports of electrical goods during the first half of 1955 the downward trend continued. Total value was $9,785,000 compared with $11,684,000 during the corresponding period of the previous year. Conspicuous decreases were shown in radio apparatus (approximately halved) and in heating and cooking appliances. On the other hand there were increases in transformers and parts and insulated copper wire.

IMPORTS

Class of Equipment	Jan.–June 1955 $ (000)	Inc. or dec. on Jan.–June 1954 $ (000)
Vacuum cleaners	1,525	– 253
From U.K.	312	– 431
,, Netherlands	22	– 104
,, Sweden	10	+ 10
,, U.S.A.	1,177	– 271
Washing machines	1,789	+ 209
From U.K.	11	– 66
,, U.S.A.	1,778	– 275
Cooking stoves	1,310*	– 234
Refrigerators	10,154	– 1,974
From U.K.	89	– 6
,, U.S.A.	10,065	– 1,968
Batteries, flashlight, and parts	55	– 23
From Hongkong	3	– 3
,, U.S.A.	52	– 29
Batteries, hearing aid, and parts	226*	– 39
Batteries, primary, n.o.p.	152	+ 9
From U.K.	9	– 2
,, France	7	– 7
,, U.S.A.	133	+ 1
Batteries, storage, and parts	735	– 391
From U.K.	55	– 53
,, U.S.A.	666	– 350
Heating apparatus	596	+ 52
From U.K.	14	—
,, W. Germany	10	+ 6
,, U.S.A.	570	+ 48
Dynamos, generators and parts, n.o.p.	4,705	+ 686
From U.K.	448	+ 32
,, W. Germany	22	+ 9
,, Switzerland	26	– 75
,, U.S.A.	4,066	+ 589
,, Sweden	133	+ 133
Fuse plugs, cutouts and parts	543	+ 65
From U.K.	51	+ 6
,, U.S.A.	491	+ 58
Fluorescent tubes and arc lamps	352	+ 1
From U.K.	6	+ 5
,, W. Germany	3	+ 3
,, U.S.A.	343	– 7
Lamps, m.f.	1,490	+ 670
From Japan	105	+ 84
,, Netherlands	91	+ 68
,, U.S.A.	1,267	+ 519
Lights, head, side, tail and torches	830	+ 260
From Hongkong	253	+ 191
,, W. Germany	12	– 2
,, U.S.A.	535	+ 72
Electric light fixtures, n.o.p.	2,867	+ 202
From U.K.	33	+ 5
,, W. Germany	38	+ 15
,, Italy	22	– 1
,, U.S.A.	2,718	+ 175
Lightning arrestors and reactors	188	+ 19
From Switzerland	32	+ 15
,, U.S.A.	143	+ 64
Electric meters and parts, n.o.p.	1,188	+ 188
From U.K.	127	– 28
,, Japan	12	+ 12
,, Switzerland	70	– 5
,, U.S.A.	1,025	+ 207
Electric motors under $10	104	– 25
From Belgium	7	+ 6
,, U.S.A.	88	– 35
Electric motors, n.o.p., and parts	6,459	+ 419
From U.K.	876	– 134
,, Belgium	15	– 2
,, W. Germany	48	+ 15
,, Sweden	45	+ 8
,, Switzerland	43	+ 29
,, U.S.A.	5,424	+ 498
Rheostats, controllers and starters	4,008	– 412
From U.K.	179	– 128
,, Switzerland	28	– 5
,, U.S.A.	3,787	– 392
Irons and parts	335	+ 134
From U.K.	24	+ 11
,, U.S.A.	311	+ 123
Self-contained lighting outfits	53	+ 30
From U.K.	2	+ 2
,, U.S.A.	50	+ 27
Sockets, outlets and receptacles	1,211*	+ 394
Switches, switchboards and parts	5,064	– 343
From U.K.	547	+ 65
,, W. Germany	15	+ 12
,, Netherlands	16	+ 16
,, Sweden	18	+ 18
,, Switzerland	264	– 132
,, U.S.A.	4,197	– 326
Switchgear for mines	19	– 34
From U.K.	16	– 14
,, U.S.A.	3	– 20
Telegraph apparatus and parts	980	– 503
From U.K.	124	– 33
,, U.S.A.	842	– 482
Telephone apparatus and parts	5,712	+ 219
From U.K.	885	– 12
,, Sweden	44	+ 29
,, Switzerland	16	– 15
,, U.S.A.	4,763	+ 218
Transformers and parts, n.o.p.	2,571	– 241
From U.K.	395	– 281
,, Sweden	241	+ 236
,, Switzerland	41	– 84
,, U.S.A.	1,863	– 137
Radio tubes	5,007	+ 2,168
From U.K.	72	– 31
,, Netherlands	62	—
,, U.S.A.	4,866	+ 2,092
Radio apparatus, n.o.p.	28,500	+ 5,221
From U.K.	2,539	+ 897
,, Netherlands	189	– 10
,, U.S.A.	25,751	+ 4,329
Dry shaving machines	1,120	– 354
From W. Germany	88	+ 88
,, Netherlands	71	– 2
,, U.S.A.	941	– 449
Electric/steam generators and parts	1,387	+ 484
From U.K.	902	+ 829
,, Switzerland	443	+ 162
,, U.S.A.	42	– 507
Electric precision instruments	3,540	+ 670
From U.K.	163	– 24
,, W. Germany	18	+ 10
,, Switzerland	10	+ 1
,, U.S.A.	3,330	+ 742
Radio receiving sets	556	+ 99
From U.K.	12	– 5
,, W. Germany	23	+ 14
,, U.S.A.	518	+ 88
Television receiving sets	245*	– 568
Radio set parts, Tariff 4450	4,754	+ 771
From U.K.	282	+ 50
,, Netherlands	95	+ 28
,, U.S.A.	4,366	+ 584
Radio tube parts, Tariff 445P	2,808*	+ 535
Sound equipment	1,463	+ 139
From U.S.A.	1,397	+ 127

* Mainly from U.S.A.

EXPORTS

Class of Equipment	Jan.–June 1955 $ (000)	Inc. or dec. on Jan.–June 1954 $ (000)
Storage batteries	49	– 92
To Colombia	18	– 55
,, Egypt	6	– 7
,, Thailand	2	– 1
,, Venezuela	4	– 8
,, U.S.A.	3	– 1
Storage battery parts	59	+ 25
To South Africa	12	+ 10
,, Egypt	2	– 4
,, Venezuela	9	– 3
,, U.S.A.	31	+ 21
Batteries, n.o.p. and parts	12	– 63
To Trinidad	1	—
,, France	4	+ 4
,, Switzerland	2	+ 1
Radio receiving sets	384	– 9
To Chile	7	– 16
,, Cuba	8	+ 6
,, Korea	10	+ 3
,, Panama	10	+ 7
,, Thailand	226	+ 221
,, Venezuela	31	– 16
,, U.S.A.	52	– 59
Radio apparatus, n.o.p.	2,449	– 2,058
To U.K.	76	+ 40
,, India	812	+ 751
,, Australia	66	+ 66
,, Colombia	54	+ 54
,, W. Germany	289	+ 289
,, Mexico	53	+ 53
,, Portuguese West Africa	32	+ 32
,, U.S.A.	994	– 2,405
Telegraph and telephone apparatus	878	+ 49
To India	83	+ 83
,, Brazil	52	+ 51
,, Mexico	26	+ 22
,, Peru	6	+ 4
,, Venezuela	9	– 9
,, U.S.A.	680	– 100
Transformers and parts	1,212	+ 367
To India	113	+ 113
,, Ceylon	65	+ 65
,, New Zealand	58	+ 58
,, Brazil	759	+ 181
,, Chile	155	+ 155
Generators and parts	650	– 157
To India	12	+ 4
,, Brazil	583	– 122
,, U.S.A.	21	– 36
Meters and parts	626	+ 32
To Ceylon	13	+ 13
,, Australia	16	+ 7
,, Bolivia	21	+ 7
,, Brazil	189	– 26
,, Colombia	66	+ 25
,, Costa Rica	60	+ 41
,, Cuba	56	+ 33
,, Dominican Republic	26	+ 11
,, Mexico	49	– 72
,, Venezuela	57	+ 12
Motors and parts	433	– 85
To South Africa	16	+ 15
,, New Zealand	19	– 6
,, Colombia	46	+ 35
,, Puerto Rico	18	+ 18
,, Venezuela	23	– 8
,, U.S.A.	250	– 52
Switches and wiring devices	158	+ 114
To Trinidad	22	+ 20
,, Brazil	76	+ 69
,, Netherlands	19	+ 19
Refrigerators, power, and parts	321	+ 235
To South Africa	105	+ 105
,, Iran	30	+ 29
,, U.S.A.	73	+ 57
Elec. washing machines, domestic	260	– 26
To South Africa	23	+ 10
,, Peru	21	– 13
,, Switzerland	38	+ 10
,, Lebanon	35	+ 33
Elec. cooking stoves	46	+ 17
To U.K.	17	+ 3
,, Bermuda	9	+ 9
Elec. heating and cooking devices	22	– 204
To Jamaica	2	+ 1
,, Peru	6	+ 4
,, U.S.A.	6	– 206
Insulated copper wire	3,970	+ 1,668
To Colombia	130	– 58
,, Cuba	101	+ 74
,, India	69	+ 69
,, Philippines	108	– 143
,, U.S.A.	3,132	+ 1,695

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 25th January from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1951

4641. Standard Telephones & Cables, Ltd.—Remote control and supervision systems. 22nd February, 1952. (743701.)

28742. Infra Red Development Co., Ltd. —Electronic restoring or balancing circuits. 8th December, 1952. (743702.)

1952

15242. General Electric Co., Ltd., and Williams, C. E.—Electric circuit arrangements for operating low pressure electric discharge lamps. 10th June, 1953. (743844.)

15909. Sangamo Weston, Ltd.—Movable coil relays of the magnetic contact type. 24th June, 1952 (743705.)

21457. General Electric Co., Ltd., Dressler, R. L., and Harwood, A. E. J.—Protective control arrangements for a.c. circuits. 26th October, 1953. (743983.)

22379 and 24843. English Electric Co., Ltd.—Electrical relays. 4th September and 2nd October, 1953. (743985 and 743988.)

22854/5. McGraw Electric Co.—Electric motor pump unit. 11th September, 1952. (743778/9.)

25157. Electricité de France.—Means for discriminating the sign of the difference of two frequencies, in particular for tele-control and tele-metering arrangements. 7th October, 1952. (743780.)

27747. Muirhead & Co., Ltd.—Rotary electric stud switches. 20th October, 1953. (743709.)

30413. Telefonaktiebolaget L. M. Ericsson.—Apparatus for indicating and localizing leaks in gas-pressure protected electric cables. 1st December, 1952. (743848.)

31115. Telefonaktiebolaget L. M. Ericsson.—Cold cathode glow discharge tubes. 8th December, 1952. (743849.)

31319. Fleischmann, E., and Fleischmann, J.—Electrical model and toy railways. 10th December, 1952. (743711.)

32007. Reyrolle & Co., Ltd., A.—High voltage electrical apparatus. 15th March, 1954. (743787.)

32994. Pirelli Soc. Per Azioni.—Electrically conductive fibres and fabrics. 30th December, 1952. (743909.)

1953

3411. English Electric Co., Ltd.—Polyphase electric rectifiers. 6th May, 1954. (743854.)

3483. Gratzmuller, J. L.—Cable connections. 6th February, 1953. (743790.)

3581. British Dielectric Research, Ltd.—Manufacture of electric circuit components. 8th February, 1954. (743717.)

5817. Pilkington Bros., Ltd.—Manufacture of electrical resistances for domestic heating. 17th February, 1954. (743915.)

6081. Young, S. G.—Electric junction boxes. 29th March, 1954. (743721.)

7000. Radio-Industrie. — Protection of electrical measuring apparatus. 13th March, 1953. (743723.)

7369. General Electric Co., Ltd.—Production of magnetizable powder suitable for the manufacture of permanent magnets. 8th March, 1954. (743791.)

7504. General Electric Co., Ltd., Brown, K. W., and Polgreen, G. R.—Production of magnetizable powder suitable for the manufacture of permanent magnets. 5th March, 1954. (743792.)

8322. General Electric Co., Ltd., and Wiles, K. F.—Formation of metallic films on articles by thermal evaporation. 22nd March, 1954. (744002.)

8339. Clewley, C. E.—Television aerials. 17th June, 1954. (743794.)

9076. Johnson & Phillips, Ltd., and Hartley, A. C.—Apparatus for holding, braking or winding cables, hawsers, threads or the like. 1st April, 1954. (743862.)

9667. General Electric Co.—Colour television tubes having apertured screen members. 9th April, 1953. (743796.)

10066. Elliott Bros. (London), Ltd.—Electron discharge tubes. 13th April, 1954. (743797.)

10260. Parsons, Ltd., C. H., and Handley, G. B.—Screened entry socket units of electric plug and socket connectors. 14th April, 1954. (744006.)

10313. Metropolitan-Vickers Electrical Co., Ltd.—Liquid immersed circuit-breakers. 12th March, 1954. (743864.)

13324. Sperry Gyroscope Co., Ltd.—Adaptors for wire-terminal valves and other wire-terminal electrical components. 13th May, 1954. (744012.)

13738. Elliott Bros. (London), Ltd.—Waveguide mode transformers. 10th May, 1954. (743801.)

14702. Oldham & Son, Ltd.—Portable electric battery lamps. 23rd February, 1954. (743733.)

14847. Tucker & Co., Ltd., J. H., and Tucker, J. B.—Electric tumbler switches. 24th May, 1954. (743734.)

16595/6. Metropolitan-Vickers Electrical Co., Ltd.—Braking of mine winders, hoists and the like. 26th May, 1954. (743804/5.)

17797. Saunders-Roe, Ltd., Isle, D. E. S., and Blackwell, H. R.—Electromagnetically switched continuous multiplying circuit. 22nd July, 1954. (744014.)

17887. Birlec, Ltd.—Electric furnaces. 28th June, 1954. (743935.)

18926. Prince, D. C.—Electric circuit-breakers having arc extinguishing means. 8th July, 1953. (743939.)

18947. British Thomson-Houston Co., Ltd.—Polyphase dynamo-electric machines. 7th May, 1954. (743741.)

19075. Precision Equipment, Inc.—Arc welding. 9th July, 1953. (743806.)

19777. Foxboro Co.—Automatically balanced potentiometric measuring apparatus incorporating transistor amplification. 16th July, 1953. (743807.)

19909. Uhrenfabrik Senden Ges.—Automatically electrically wound spring-driven timepieces. 17th July, 1953. (743744.)

21047. Standard Telephones & Cables, Ltd.—Mounting of electric discharge devices. 16th July, 1954. (743945.)

21990. English Electric Co., Ltd.—Electric speed regulators. 9th August, 1954. (743810.)

22492. Standard Telephones & Cables, Ltd.—Travelling-wave tubes. 14th August, 1953. (744018.)

22527. General Electric Co., Ltd., Breadner, R. L., and Simms, C. H.—Vapour diffusion pumps. 21st June, 1954. (743754.)

24506. Siemens-Reiniger-Werke Akt.-Ges.—Short wave treatment apparatus. 4th September, 1953. (743884.)

24523. General Electric Co.—Clothes washing and/or drying machines. 4th September, 1953. (744022.)

26251. British Insulated Callender's Cables, Ltd.—Application of sheaths to electric cables. 22nd September, 1954. (743819.)

27097. British Thomson-Houston Co., Ltd.—Control circuits for high frequency electronic oscillators. 23rd September, 1954. (743887.)

28233. Etablissements A. Herlicq & Fils Soc. Anon.—Pylon for electric power transmission and distribution lines. 13th October, 1953. (743949.)

29212. Philco Corporation.—Television receiving systems. 22nd October, 1953. (744028.)

29834. Radio Corporation of America.—Semi-conductor d.c. stabilization circuit. 28th October, 1953. (743824.)

31307. Landis & Gyr Akt.-Ges.—Multiple tariff counting mechanism for measuring instruments, particularly electricity meters. 11th November, 1953. (744031.)

32995. English Electric Co., Ltd.—Dynamo-electric machines. 26th November, 1954. (743762.)

33146. Allday & Son (1922), Ltd., H.—Wall box for containing an electric switch or other circuit controlling or connecting means. 3rd November, 1954. (743837.)

33735. Westinghouse Electric International Co.—Polyphase dynamo-electric machines incorporating protection against overheating. 4th December, 1953. (743765.)

1954

1987. General Electric Co., Ltd., and Williams, C. E.—Electric circuit arrangements for operating low pressure electric-discharge lamps. 19th January, 1955. (743898.)

18297. General Electric Co., Ltd., and Williams, C. E.—Electric circuit arrangements for operating low pressure electric-discharge lamps. 10th June, 1953. (743899.)

1955

15753. Ismay Lamps, Ltd., and Deshaw, Z.—Packaging of electric lamp bulbs and apparatus therefor. 17th July, 1953. Divided out of 744017. (744040.)

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 30th December:—

DYNASTART. No. B743,511, Class 7. Dynamos and parts.—Siba Electric, Ltd., Brook House, Torrington Place, W.C.1.

PETTER. No. 746,099, Class 7. Internal combustion engines (not for land vehicles), blowers for i.c. engines, electric generators, lighting dynamos, portable spraying plants, and pumps. No. 746,101, Class 11. Lighting apparatus and appliances.—Petters, Ltd., Causeway Works, Staines, Middx.

PYE-FI. No. 741,063, Class 9. Scientific, radar, echo-sounding, nautical, signalling, navigational, radio, television, telegraphic, telephonic and telecommunication apparatus and instruments; domestic electrical appliances and electrical, acoustical and electronic apparatus and instruments; batteries, accumulators, microphones, amplifiers, loudspeakers, electric oscillation generators, germanium diodes, transistors, electric semi-conducting materials, etc.—Pye, Ltd., Radio Works, St. Andrews Road, Cambridge.

MULLARD. No. B741,313, Class 9. All goods included in Class 9, all being operated or controlled by electric or electronic means, or incorporating electric or electronic apparatus.—Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

SERVOTROL. No. 742,870, Class 9. Instruments and apparatus for measuring, indicating, recording and controlling temperatures, conductivity, hydrogen ion concentration, electric current, voltage, optical density, smoke, atmospheric suspensions and pressure; safety devices, being instruments for controlling and indicating failure in gas and electrical equipment; and electric control valves for use with these goods, none being apparatus incorporating electric discharge tubes.—Ether, Ltd., Tyburn Road, Erdington, Birmingham, 24.

RHONAX. No. 743,880, Class 9. Electrical apparatus and instruments; scientific, optical, cinematographic and sound-reproducing instruments and apparatus, etc.—Société des Usines Chimiques, Rhone-Poulenc, Paris, France. Address for service, c/o W. Symmons & Co., Bank Chambers, 329, High Holborn, London, W.C.1.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia.—27th January. Mackay Harbour Board, North Queensland. Main switchboard. (E.S.B. 27056/55. Ten/17097.)*

31st January. Director, Posts and Telegraphs Department, G.P.O., Melbourne. Switchboard lamps, caps and sockets. (E.S.B. 26371/55. Ten/17019.)* 2nd February. Handsets and telephonists' telephones. (E.S.B. 26747/55. Ten/17087.)* Uniselector maintenance parts. (E.S.B. 26749/55. Ten/17086.)* 7th February. Uniselector maintenance parts. (E.S.B. 26748/55. Ten/17084.)*

7th March. State Electricity Commission, Brisbane. Two 150 kW sets for Emerald Shire Council. (E.S.B. 27057/55. Ten/17101.)*

Cuba.—5th January. Primira Central Hidroelectrica Cubana, Havana. 115 kV switching equipment and station battery equipment for the Hanabanilla project. (E.S.B. 27308/55. Ten/17110.)* 9th January. Switchboards and carrier current equipment for the Hanabanilla project. (E.S.B. 27307/55. Ten/17109.)*

Edinburgh.—North of Scotland Hydro-Electric Board. 132 kV isolators, 33 kV switchgear, neutral earthing resistances and ancillary equipment for Persley substation. (See this issue.)

Egypt.—23rd January. Cairo Tramway Co. 100-125 trolley-buses. (E.S.B. 25828/55. Ten/17071.)*

Formosa.—13th January. Central Trust of China, Taipei. Watthour meters. (E.S.B. 26946/55. Ten/17098.)*

India.—4th January. Electricity Department, United Provinces, Lucknow. 3·3 kV switchgear. (E.S.B. 27195/55. Ten/17118.)*

27th January. India Store Department. Transmission line material. (See this issue.)

10th February. Electrical machinery and laboratory equipment for an engineering college. (See this issue.)

22nd March. Government Central Stores Purchase Organization, Bombay. Transmission lines for Koyna hydro-electric project. (E.S.B. 27058/55. Ten/17089.)* Power transformers. (E.S.B. 27059/55. Ten/17100.)* 26th March. Power transformers. (E.S.B. 27059/55. Ten/17100.)*

Iraq.—13th February. Ministry of Development, Baghdad. Three 15,000 kW turbo-generators for Dibis power station, and two 20,000 kW turbo-generators for Baghdad station. (E.S.B. 23761/55. Ten/17068.)*

New Zealand.—31st January. Director General, Stores Division, G.P.O., Wellington. Electric cable test equipment. (E.S.B. 26824/55. Ten/17048.)*

Pakistan.—16th January. Director General of Supply and Development, Karachi. Power cable, connectors, electric lighting fittings, switchboard and fuses. (E.S.B. 27018/55. Ten/17099.)*

South Africa.—9th January. Kimberley City Electricity Department. Street lighting fittings. (E.S.B. 27357/55. Ten/17136.)*

11th January. Stores Department, South African Railways. Insulated electric cable. (E.S.B. 27363/55. Ten/17127.)*

13th January. Durban Electricity Department. Underground electric cable. (E.S.B. 26875/55. Ten/17119.)* Three-phase transformers, ranging from 50 kVA to 750 kVA. (E.S.B. 26876/55. Ten/17120.)*

19th January. Union Tender and Supplies Board, Pretoria. Magneto extension switches. (E.S.B. 26954/55. Ten/17074.)* Vacuum cleaners and floor polishers. (E.S.B. 26957/55. Ten/17056.)*

20th January. Durban Electricity Department. E.h.v. automatic circuit reclosers. (E.S.B. 26877/55. Ten/17108.)*

Stockton-on-Tees.—4th January. Corporation. Re-lighting of trunk road. (See this issue.)

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Isle of Ely.—County Council Education Committee. Accepted. Electrical installation work in the new High School at Ely (£7,220). —Ely Electrical Co., Ltd.

Newcastle-on-Tyne. — Education Committee. Supply and installation of a lift at Northern Counties Training College of Cookery (£2,460).—Austin Lifts, Ltd.

Southampton. — Corporation. Recommended. Electrical installation at the Portswood Secondary Junior & Infants' School (£2,402).—H. C. Taplin & Sons, Ltd.

West Hartlepool.—Corporation. Accepted. 50 electric wash-boilers.—William Marshall (Middlesbrough), Ltd.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Acton.—Flats (168), Bollo Bridge area; borough engineer, Town Hall, London, W.3.

Alnwick.—Houses (40), for R.D.C.; T. J. Cahill, architect, Lloyds Bank Chambers, Alnwick.

Ashton-under-Lyne. — Houses (134), Charlestown; G. A. Malone, town clerk, Town Hall.

Beckenham.—Flats (120), Cator estate; borough engineer.

Berwick.—New premises at the junction of Walkergate and Hatters Lane, for Border Steam Laundry, Ltd.; C. Solomon, architect, 30, St. Mary's Place, Newcastle-on-Tyne.

Birmingham. — Police station, Bradford Street and Bloom Street; F. Deeley, Ltd., 210, High Street, Harborne.

Reconstruction of premises, Station Street, for Colmore Depot, Ltd.; T. Elvins & Sons, Ltd., Soho Hill, Birmingham.

Blackley.—Crematorium; G. & J. Seddon, Ltd., Little Hulton, near Bolton.

Blackpool.—Houses (139) and flats (12), Grange Park estate extension; Middleton & Co. (Blackpool), Ltd., Bank Street Sidings, Blackpool.

Bolton.—Hotel, Crompton Way and Tonge Moor Road, for Peter Walker (Warrington), Ltd.; Wm. Gornall & Sons, Ltd., Ellesmere Street, Bolton.

Bredbury.—Houses (161), and 36 maisonnettes and flats, in connection with overspill development; director of housing, Town Hall, Manchester, 2.

Bristol.—Three-storey warehouse, Meridian Place, Clifton; Lalonde Bros. & Parham, removal contractors, 64, Queens Road.

Chepstow.—Houses (58), Rogiet site, for R.D.C.; Thomas & Morgan & Partners, architects, 23, Gelliwastad Road, Pontypridd.

Chester.—Depot and offices, Sealand trading estate; Raleigh Industries, Ltd., Lenton Boulevard, Nottingham.

Croydon. — Works extensions; Ariston Alloys, Ltd., Mill Lane.

Dewsbury.—R.C. School of St. John Fisher; borough architect.

Doncaster.—Furniture repository, workshops, garages, etc., Littlemore Lane/Stevens Road site; L. C. Carpenter, Ltd., haulage contractors, 20, Scot Lane.

Secondary modern school, Intake (£156,978); borough architect.

Proposed new civic centre; Frederick Gibberd, architect, 8, Percy Street, London, W.1.

Dover.—Hotel, Camden Street/New Townwall Street site; Watney, Combe, Reid & Co., Ltd., Stag Brewery, London, S.W.1.

Dudley.—Works; James Dison (Constructional Engineers), Ltd., Dibdale Road.

Ealing.—Works extensions; Brillo Manufacturing Co., Ltd., Brillo Works, North Circular Road.

Eccles.—Houses (174), shops with flats, Brookhouse estate; Bower Moffatt & Co., Ltd., Manchester.

Eston.—Houses (20), Teesville estate; N. C. Harrison, surveyor, 246, Normanby Road, South Bank.

Evesham.—Houses (122); R.D.C. surveyor, Council Offices, Lansdowne, Port Street.

Exeter.—Admission unit for Digby Hospital; South Western Regional Hospital Board, Parklands, Tyndall Park Road, Clifton, Bristol.

Hall for St. Luke's College, Heavitree Road; clerk to the governors.

Farnworth.—Houses (74), Plodder Lane South; E. F. Davis, Ltd., Bank Street, Farnworth.

Fletton.—Police station (£52,000), for Hunts County Council, during 1956-57; county architect, Huntingdon.

Godalming.—Development of site at Green Lane, Farncombe, with 100 houses; Chas. Osenton & Co., estate agents, 1, Quarry Street, Guildford.

Greenford.—Warehouse, printing department, and canteen; Glaxo Laboratories, Ltd., Greenford Road.

Hebburn.—Five nursery schools and primary school; county architect, South Street, Durham.

Hemel Hempstead.—"Top of the World" Hotel; S. C. Clarke, architect, 86, Fenchurch Street, London, E.C.3.

Heywood.—Extensions to works at Crimble Mill, for James Kenyon; R. Jay, architect, North Ward Chambers, 15, Oldham Road, Rochdale.

Ilford.—Extensions to county high school for boys and Barking Abbey School; H. R. Lewis, architect, 68, Cranbrook Road.

Dwellings (253), Loxford estate; town clerk, Town Hall.

Keighley.—Houses (44), Exley Head; Frederick W. Heaton (Builders), Ltd., 15, Lynton Drive, Riddlesden, Keighley.

Kirkcaldy.—Extensions to surgical departments at Victoria Hospital (£625,000); South Eastern Regional Hospital Board, 11, Drumsheugh Gardens, Edinburgh.

Leicester.—Junior and infants' schools, Wigston Fields; city architect.

Dwellings (1,200) in re-development areas during 1956; J. H. Lloyd Owen, city architect, 7, Newarke Street.

Manchester.—Stage 2 of Openshaw College of Further Education; W. J. Simms, Son & Cooke, Ltd., Haydn Road, Nottingham.

March.—Extensions to Hereward School for Isle of Ely C.C.; J. E. Mitchell, architect.

Matlock.—Multiple store and warehouse, Causeway Lane; F. W. Woolworth & Co., Ltd., King Street, Dudley.

Morecambe.—Rebuilding Imperial Hotel, Regent Road; Peter Walker (Warrington), Ltd., 105, Duke Street, Liverpool.

Newcastle-on-Tyne.—Five-storey flats and maisonnettes, Fawdon estate and in Scotswood Road re-development area; city architect, 18, Cloth Market.

Factory in Penn Street for Austin Lifts, Ltd., and factory in Temple Street for Hall Forster, Ltd.; Tasker and Child, architects, 25, New Bridge Street.

Primary school, Montague estate, for the E.C.; Turley and Williamson, architects, 46, Jesmond Road.

Secondary technical school, Stamfordham Road, for the E.C.; L. J. Couves and Partners, architects, Carliol House.

North Shields.—Operating theatre, Preston Hospital, for Newcastle Hospital Board, Benfield Road; own architect.

Showrooms for the Coast Road Motor Co., Ltd., Queen Alexandra Road; R. Walton, architect, Shotley Bridge, Co. Durham.

Northwich.—Secondary school at Barnton, for Cheshire C.C.; F. M. Parkes, county architect, Chester.

Nottingham.—Girls' school at Perry Road, for E.C.; A. G. Clower, Ltd., Mansfield Road, Daybrook.

Oldham.—Workshops and offices, Glodwick Road; Cruickshank & Seward, architects, 196, Deansgate, Manchester.

Buildings at Glodwick Road, for Cleansing and Transport Committee; Cruikshank & Seward, architects, 196, Deansgate, Manchester.

Peterlee (Co. Durham).—Factory for K.X. Lamps, Ltd.; Sir W. Holford and Partners, architects, 80, Bedford Street South, Liverpool.

Plymouth.—Shops (34) and flats (42), Pannier Market Street; city architect.

Purley.—Chapel for John Fisher School; W. H. Gaze & Sons, Ltd., builders, High Street, Kingston-on-Thames.

Rainham.—Factory; C. V. Clements & Co., 617, Green Lane, Goodmayes.

Reading.—Industrial premises on site at Cardiff Road; Berkshire Mobile Welding Service, Ltd., 125, Armour Road, Tilehurst.

Salisbury.—Reconstruction of club premises in High Street, to form departmental stores; F. W. Woolworth & Co., Ltd., 1, New Bond Street, London, W.1.

Saltburn.—County modern school, Brotton; Hadfield, Cawkwell & Davidson, architects, 1, High Court, Sheffield.

Scarborough.—Block of shops and maisonnettes in St. Thomas Street; O. Garry, architect, 15, Robert Adam Street, London, W.1.

Sheffield.—Factory, Hunter Road, for A. L. Simpkin & Co.; T. Holmes & Sons, Ltd., Bradway, Sheffield.

Library for Sheffield University; W. J. Simms, Sons & Cooke, Ltd., Nottingham.

Smethwick.—Houses (158) at Kingsway West site, for T.C.; Eadie & Co. (Wolverhampton), Ltd., 29 Waterloo Road, Wolverhampton.

South Shields.—Houses (62) at Simonside, for the T.C.; William Leech, Ltd., builders, 2, Clayton Street, Newcastle-on-Tyne.

Spennymoor.—Bus station and market; G. H. Gray & Partner, Camden Street, North Shields.

Stevenage.—Factory, Six Hills Way, for the Mentmore Manufacturing Co., Ltd., Platignum House, Tudor Grove, London, E.9; H. Courtenay Constantine, architect, 28, West Street, Marlow.

Stockton-on-Tees. — New St. Chad's Church, Roseworth estate; Cordingley and McIntyre, architects, The College, Durham.

Houses (42), Albany Road, for the T.C.; Moore and Cartwright, Ltd., builders, High Street, Norton.

Stoke-on-Trent. — Houses at Bambury Street, Longton (240), Fenton (34), and Trent Vale (18); W. A. Bott, borough surveyor, Town Hall.

Stratford-on-Avon.—Crown Office building; Espley & Co., Ltd., builders, 77, High Street, Evesham.

Stretford.—Extensions to premises at Ayres Road, for International Biscuit Co., Ltd.; Jones & Rawlinson, Ltd., Leaf Square, Salford.

Sunderland.—Additions to Lamson Paragon Co.'s factory at Pallion; Gordon Durham and Co., builders, East Boldon.

Surbiton.—Office block; Crystal Products, Ltd., Hook Rise.

32 flats, Herne Road; Thorogood & Sons, Ltd., 55, Bond Road.

Swansea.—Cinema, 212/216, High Street; Odeon Theatres, Ltd., 59, New Oxford Street, London, W.C.1.

Titanium works, Landore; Imperial Chemical Industries, Ltd., I.C.I. House, Millbank, London, S.W.1.

Houses (116), Blaen y Maes estate; borough architect.

Torquay.—Coach station, Upton Valley; borough engineer.

Tottenham.—Lord Morrison Hall, Chestnut Road; borough engineer, Town Hall, Tottenham, London, N.15.

Tynemouth.—Offices, workshops, plant, storage accommodation, etc., at Howdon; Dowsett Group of Companies, Tallington, Stamford, Lincs.

Wallasey.—Houses (30) and flats (9), at site P.6, for B.C.; J. L. Rawsthorne, Ltd., Belvedere Sawmills.

Warwick.—Council chamber and three-storey office extensions for Warwickshire C.C. (£125,000); Foster & Dicksee, Ltd., builders, James Street, Rugby.

West Bromwich.—Buildings at the Lyttleton Hall estate, for McArthur & Co. (Steel & Metal), Ltd., Coseley Engineering Co., Ltd., Bilston.

West Ham.—Offices, The Grove; borough architect and planning officer.

West Lancashire.—Houses at Maghull (310), Aintree (200), and Lydiate (180), to be erected during 1956; R.D.C. surveyor, Council Offices, 52, Derby Street, Ormskirk.

Whiston. — Twin operating theatres, Whiston Hospital; Liverpool Regional Hospital Board, 88, Church Street.

Whittlesey.—Junior school for Isle of Ely C.C.; Ruddle & Wilkinson, architects, Longcauseway, Peterborough.

Wimblington. — Enlargement of school (£18,000); county architect, March, Cambs.

Wisbech.—Old people's home for Isle of Ely County Council (£37,000); county architect, March, Cambs.

Wolverhampton.—Flats (60), at Wednesfield No. 2 site, for T.C.; Gregory Housing, Ltd., Worthing, Sussex.

Foundry, Albion Street; John Hill & Sons, Ltd., Albion Works, Horsley Fields.

Pathological laboratory; Birmingham Regional Hospital Board, 10, Augustus Road, Birmingham, 15.

East African Imports

After a big increase in 1953, imports of power plant into Kenya, Uganda and Tanganyika last year declined. There were marked decreases also in cables and in the telegraph and telephone group. On the other hand the radio trade progressed substantially, particularly in Tanganyika. While that territory displayed an advance in purchasing power in a number of lines, Kenya remained the most important market. The United Kingdom maintained its position as by far the leading supplier. The accompanying table shows the values of the principal lines imported last year with notes of increases or decreases where possible. As the classification has been somewhat altered while new headings have appeared and other headings have been dropped, comparative figures cannot always be given.

Class of Goods	Kenya		Uganda		Tanganyika	
	1954 £ (000)	Inc. or dec. on 1953 £ (000)	1954 £ (000)	Inc. or dec. on 1953 £ (000)	1954 £ (000)	Inc. or dec. on 1953 £ (000)
Generators, motors, convertors and transformers	561*	− 182	499*	− 68	210	− 119
Lamp and torch batteries	48	+ 6	17	—	29	—
From Malaya	35	+ 6	12	+ 2	21	—
„ South Africa	8	—	3	− 1	3	− 2
Batteries and accumulators, n.e.s.	22	†	8	†	22	+ 4
From U.K.	12	—	6	—	14	+ 6
„ South Africa	6	—	—	—	5	+ 1
Bulbs and tubes for lighting, domestic	35	+ 10	15	+ 5	20	+ 12
From U.K.	13	− 3	6	− 1	9	+ 3
„ Netherlands	16	+ 7	8	+ 5	10	+ 9
Radio receiving sets, domestic	138	+ 26	60	+ 33	142	+ 88
From U.K.	40	− 24	23	+ 7	85	+ 52
„ Netherlands	61	+ 28	26	+ 18	51	+ 31
„ West Germany	31	+ 25	8	+ 6	5	+ 4
Radio receiving sets, other, and spares	164	− 14	84	+ 55	34	+ 9
From U.K.	147	− 21	79	+ 52	31	+ 9
Insulated cables and wires	250*	− 189	108*	− 190	121	− 37
Electro-thermic apparatus	65	†	45	†	30	†
From U.K.	55	—	40	—	26	—
Telegraph and telephone instruments and apparatus	289*	− 196	9*	− 6	73*	− 17
Portable tools and appliances and small domestic devices not over 15 kg.	54	—	15	+ 2	39	+ 24
From U.K.	40	− 6	10	− 1	28	+ 14
„ West Germany	5	—	1	—	1	+ 1
Elec. appliances for motor vehicles, etc.	30	− 1	73	+ 17	36	+ 23
„ From U.K.	11	− 8	64	+ 13	29	+ 18
„ Netherlands	6	+ 2	6	+ 3	2	+ 1
„ U.S.A.	7	+ 3	—	—	—	—
Measuring, controlling, signalling and safety appliances	26*	†	10*	†	10	†
Medical and radiological apparatus	9	†	2	†	7	†
Motor vehicle batteries	121	+ 39	38	− 6	70	+ 40
From U.K.	77	− 3	29	+ 29	55	+ 25
„ Australia	13	+ 13	—	—	1	+ 1
„ South Africa	17	+ 17	—	—	10	+ 10
„ West Germany	10	+ 10	5	+ 5	3	+ 3
Other machinery, appliances and apparatus	187	†	50	†	103	†
From U.K.	108	—	47	—	48	—
„ France	68	—	—	—	32	—

* Mainly from U.K. † Comparative figures not available.